



**AD-A201 839**

**DURABILITY AND DAMAGE  
TOLERANCE OF BISMALEIMIDE  
COMPOSITES**

**VOLUME II: APPENDIX OF CRACK GROWTH AND  
LOW-VELOCITY IMPACT DATA**

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**JUNE 1988**

**Final Report for Period 13 September 1985 - 15 January 1988**

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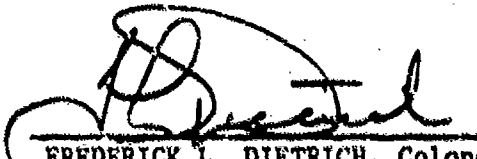


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# REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)  AFWAL/TR-88-3026, Vol II		
6a. NAME OF PERFORMING ORGANIZATION McDonnell Aircraft Company/ McDonnell Douglas Corporation		6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION Wright Aeronautical Laboratories (AFWAL/FIBEC)		
6c. ADDRESS (City, State, and ZIP Code) P.O. Box 516 St. Louis, Missouri 63166			7b. ADDRESS (City, State, and ZIP Code) Wright-Patterson Ohio 45433		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (if applicable) AFWAL/FIBEC	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER  Contract F33615-85-C-3212		
8c. ADDRESS (City, State, and ZIP Code)  Wright-Patterson AFB OH 45433-6553			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO. 62201F	PROJECT NO. 2401	TASK NO. 01
			WORK UNIT ACCESSION NO. 94		
11. TITLE (Include Security Classification) Durability and Damage Tolerance of Bismaleimide Composites Volume II: Appendix of Crack Growth and Low Velocity Impact Data					
12. PERSONAL AUTHOR(S) S. Timothy Tyahla and Paul S. McClellan, Jr.					
13a. TYPE OF REPORT Final Technical Report		13b. TIME COVERED FROM Sept 85 to Jan 88		14. DATE OF REPORT (Year, Month, Day) 88 Jun	
15. PAGE COUNT 246					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Composite Materials, Bismaleimide, Fracture Toughness, Tough Resins, Stress Analysis, Static Strength, Low Energy Impact, Damage Tolerance. (C)		
11	04				
13	13				
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>This program was the evaluation of durability and damage tolerance of bismaleimide (BMI) composites. BMI resins have been developed for structural applications in 350°F to 450°F environments. This represents an improvement over epoxy resin capability of approximately 100°F.</p> <p>In Task I of this program we experimentally evaluated two second generation BMI systems (IM6/3100 and IM6/F650) and compared their performance with that of baseline systems AS1/3501-6 and T300/V378A. The intermediate modulus fiber IM6 was chosen as the common fiber for both material systems because its high strength and stiffness are properties that are important for future fighter design.</p> <p>In Task II basic material properties were determined. The data included moisture absorption, glass transition temperature, thermal spike susceptibility, lamina properties, and interlaminar fracture toughness test results. Lamina properties and fracture toughness test data were used to correlate laminate behavior exhibited in Task III.</p> <p style="text-align: right;">(continued)</p>					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input checked="" type="checkbox"/> OTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>		
22a. NAME OF RESPONSIBLE INDIVIDUAL Lt. H. Joseph Storr			22b. TELEPHONE (Include Area Code) (513) 255-6104		22c. OFFICE SYMBOL AFWAL/FIBEC

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19. Abstract (cont.)

In Task III laminate structural characterizations of IM6/3100 and IM6/F650 were completed. Tests were performed on coupons that represented configurations found in typical aircraft designs. Specimens were fabricated and tested in notched and unnotched conditions to represent design applications.

In Task IV the better system (IM6/3100) was chosen to fabricate stiffened panels for evaluation of the bismaleimide's durability and damage tolerance in a structural configuration. Static and fatigue tests were performed on panels with and without impact damage.

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# FOREWORD

The work reported herein was performed by the McDonnell Aircraft Company (MCAIR) of the McDonnell Douglas Corporation (MDC), St. Louis, Missouri, under Air Force Contract F33615-85-C-3212, "Durability and Damage Tolerance of Bismaleimide Composites", for the Air Force Wright Aeronautical Laboratories, Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio. Lt. David L. Graves (AFWAL/FIBEC) and Lt. H. Joseph Storr (AFWAL/FIBEC) were the Air Force Project Engineers. The work described was conducted during the period 13 September 1985 through 15 January 1988.

The work was managed by the MCAIR Structural Research Department with Harold D. Dill as Program Manager and S. Timothy Tyahla as Principal Investigator. Program testing was conducted under the direction of Paul S. McClellan, Jr., MCAIR Nonmetallics and Chemical Processes Laboratory.

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# TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
APPENDIX A: CRACK GROWTH PLOTS . . . . .	A-1
A.1 CTD DATA . . . . .	A-3
A.1.1 IM6/3100 . . . . .	A-4
A.1.2 IM6/F650 . . . . .	A-8
A.2 RTD DATA . . . . .	A-13
A.2.1 IM6/3100 . . . . .	A-14
A.2.2 IM6/F650 . . . . .	A-18
A.3 ETW DATA . . . . .	A-23
A.3.1 IM6/3100 . . . . .	A-24
A.3.2 IM6/F650 . . . . .	A-28
APPENDIX B: IMPACT DAMAGE/RESIDUAL STRENGTH DATA . . . . .	B-1
B.1 MAXIMUM NON-VISIBLE IMPACT DAMAGE . . . . .	B-3
B.1.1 Data Table . . . . .	B-4
B.1.2 RTD Data Sheets . . . . .	B-5
B.1.3 ETW Data Sheets . . . . .	B-42
B.2 THIN LAMINATE IMPACT DAMAGE . . . . .	B-67
B.2.1 Data Table . . . . .	B-68
B.2.2 RTD Data Sheets . . . . .	B-69
B.2.3 ETW Data Sheets . . . . .	B-111
B.3 VISIBLE IMPACT DAMAGE . . . . .	B-137
B.3.1 Data Table . . . . .	B-138
B.3.2 RTD Data Sheets . . . . .	B-139
B.3.3 ETW Data Sheets . . . . .	B-175

# LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
A-1	IM6/3100 Mode I at CTD Conditions . . . . .	A-4
A-2	IM6/3100 Mixed Mode (CLS-63) at CTD Conditions . . . . .	A-5
A-3	IM6/3100 Mixed Mode (CLS-82) at CTD Conditions . . . . .	A-6
A-4	IM6/3100 Mode II at CTD Conditions . . . . .	A-7
A-5	IM6/F650 Mode I at CTD Conditions . . . . .	A-8
A-6	IM6/F650 Mixed Mode (CLS-63) at CTD Conditions . . . . .	A-9
A-7	IM6/F650 Mixed Mode (CLS-82) at CTD Conditions . . . . .	A-10
A-8	IM6/F650 Mode II at CTD Conditions . . . . .	A-11
A-9	IM6/3100 Mode I at RTD Conditions . . . . .	A-14
A-10	IM6/3100 Mixed Mode (CLS-63) at RTD Conditions . . . . .	A-15
A-11	IM6/3100 Mixed Mode (CLS-82) at RTD Conditions . . . . .	A-16
A-12	IM6/3100 Mode II at RTD Conditions . . . . .	A-17
A-13	IM6/F650 Mode I at RTD Conditions . . . . .	A-18
A-14	IM6/F650 Mixed Mode (CLS-63) at RTD Conditions . . . . .	A-19
A-15	IM6/F650 Mixed Mode (CLS-82) at RTD Conditions . . . . .	A-20
A-16	IM6/F650 Mode II at RTD Conditions . . . . .	A-21
A-17	IM6/3100 Mode I at ETW Conditions . . . . .	A-24
A-18	IM6/3100 Mixed Mode (CLS-63) at ETW Conditions . . . . .	A-25
A-19	IM6/3100 Mixed Mode (CLS-82) at ETW Conditions . . . . .	A-26
A-20	IM6/3100 Mode II at ETW Conditions . . . . .	A-27
A-21	IM6/F650 Mode I at ETW Conditions . . . . .	A-28
A-22	IM6/F650 Mixed Mode (CLS-63) at ETW Conditions . . . . .	A-29
A-23	IM6/F650 Mixed Mode (CLS-82) at ETW Conditions . . . . .	A-30
A-24	IM6/F650 Mode II at ETW Conditions . . . . .	A-31

# LIST OF FIGURES (Continued)

<u>Figure</u>		<u>Page</u>
B-1	Definition of Panel Strain Gage Locations . . . . .	B-2
B-2	Maximum Non-visible Impact Damage Data Table . . . . .	B-4
B-3	Panel 1-12-2 Impact Response Data . . . . .	B-5
B-4	Panel 1-12-2 C-scan . . . . .	B-6
B-5	Panel 1-12-2 Residual Compression Data . . . . .	B-7
B-6	Panel 1-11-2 Impact Response Data . . . . .	B-8
B-7	Panel 1-11-2 C-scan . . . . .	B-9
B-8	Panel 1-11-2 Residual Compression Data . . . . .	B-10
B-9	Panel 1-13-1 First Impact Response Data . . . . .	B-11
B-10	Panel 1-13-1 Second Impact Response Data . . . . .	B-12
B-11	Panel 1-13-1 C-scan . . . . .	B-13
B-12	Panel 1-13-1 Residual Compression Data . . . . .	B-14
B-13	Panel 1-14-2 Impact Response Data . . . . .	B-15
B-14	Panel 1-14-2 C-scan . . . . .	B-16
B-15	Panel 1-14-2 Residual Compression Data . . . . .	B-17
B-16	Panel 1-20-2 Impact Response Data . . . . .	B-18
B-17	Panel 1-20-2 C-scan . . . . .	B-19
B-18	Panel 1-20-2 Residual Compression Data . . . . .	B-20
B-19	Panel 1-15-2 Impact Response Data . . . . .	B-21
B-20	Panel 1-15-2 C-scan . . . . .	B-22
B-21	Panel 1-15-2 Residual Compression Data . . . . .	B-23
B-22	Panel 2-12-2 Impact Response Data . . . . .	B-24
B-23	Panel 2-12-2 C-scan . . . . .	B-25
B-24	Panel 2-12-2 Residual Compression Data . . . . .	B-26
B-25	Panel 2-11-3 Impact Response Data . . . . .	B-27
B-26	Panel 2-11-3 C-scan . . . . .	B-28
B-27	Panel 2-11-3 Residual Compression Data . . . . .	B-29
B-28	Panel 2-13-1 Impact Response Data . . . . .	B-30
B-29	Panel 2-13-1 C-scan . . . . .	B-31
B-30	Panel 2-13-1 Residual Compression Data . . . . .	B-32
B-31	Panel 2-14-1 Impact Response Data . . . . .	B-33
B-32	Panel 2-14-1 C-scan . . . . .	B-34

# LIST OF FIGURES (Continued)

<u>Figure</u>		<u>Page</u>
B-33	Panel 2-14-1 Residual Compression Data . . . . .	B-35
B-34	Panel 2-20-2 Impact Response Data . . . . .	B-36
B-35	Panel 2-20-2 C-scan . . . . .	B-37
B-36	Panel 2-20-2 Residual Compression Data . . . . .	B-38
B-37	Panel 2-15-2 Impact Response Data . . . . .	B-39
B-38	Panel 2-15-2 C-scan . . . . .	B-40
B-39	Panel 2-15-2 Residual Compression Data . . . . .	B-41
B-40	Panel 1-12-4 Impact Response Data . . . . .	B-42
B-41	Panel 1-12-4 Residual Compression Data . . . . .	B-43
B-42	Panel 1-11-5 Impact Response Data . . . . .	B-44
B-43	Panel 1-11-5 Residual Compression Data . . . . .	B-45
B-44	Panel 1-13-4 Impact Response Data . . . . .	B-46
B-45	Panel 1-13-4 Residual Compression Data . . . . .	B-47
B-46	Panel 1-14-4 Impact Response Data . . . . .	B-48
B-47	Panel 1-14-4 Residual Compression Data . . . . .	B-49
B-48	Panel 1-20-4 Impact Response Data . . . . .	B-50
B-49	Panel 1-20-4 Residual Compression Data . . . . .	B-51
B-50	Panel 1-15-4 First Impact Response Data . . . . .	B-52
B-51	Panel 1-15-4 Second Impact Response Data . . . . .	B-53
B-52	Panel 1-15-4 Residual Compression Data . . . . .	B-54
B-53	Panel 2-12-5 Impact Response Data . . . . .	B-55
B-54	Panel 2-12-5 Residual Compression Data . . . . .	B-56
B-55	Panel 2-11-6 Impact Response Data . . . . .	B-57
B-56	Panel 2-11-6 Residual Compression Data . . . . .	B-58
B-57	Panel 2-13-5 Impact Response Data . . . . .	B-59
B-58	Panel 2-13-5 Residual Compression Data . . . . .	B-60
B-59	Panel 2-14-5 Impact Response Data . . . . .	B-61
B-60	Panel 2-14-5 Residual Compression Data . . . . .	B-62
B-61	Panel 2-20-4 Impact Response Data . . . . .	B-63
B-62	Panel 2-20-4 Residual Compression Data . . . . .	B-64
B-63	Panel 2-15-4 Impact Response Data . . . . .	B-65

# LIST OF FIGURES (Continued)

<u>Figure</u>		<u>Page</u>
B-64	Panel 2-15-4 Residual Compression Data . . . . .	B-66
B-65	Thin Laminate Impact Damage Data Table . . . . .	B-68
B-66	Panel 1-16-2 First Impact Response Data . . . . .	B-69
B-67	Panel 1-16-2 Second Impact Response Data . . . . .	B-70
B-68	Panel 1-16-2 C-scan . . . . .	B-71
B-69	Panel 1-16-2 Residual Compression Data . . . . .	B-72
B-70	Panel 1-12A-1 First Impact Response Data . . . . .	B-73
B-71	Panel 1-12A-1 Second Impact Response Data . . . . .	B-74
B-72	Panel 1-12A-1 C-scan . . . . .	B-75
B-73	Panel 1-12A-1 Residual Compression Data . . . . .	B-76
B-74	Panel 1-17-2 Impact Response Data . . . . .	B-77
B-75	Panel 1-17-2 C-scan . . . . .	B-78
B-76	Panel 1-17-2 Residual Compression Data . . . . .	B-79
B-77	Panel 1-18-1 Impact Response Data . . . . .	B-80
B-78	Panel 1-18-1 C-scan . . . . .	B-81
B-79	Panel 1-18-1 Residual Compression Data . . . . .	B-82
B-80	Panel 1-14A-1 First Impact Response Data . . . . .	B-83
B-81	Panel 1-14A-1 Second Impact Response Data . . . . .	B-84
B-82	Panel 1-14A-1 C-scan . . . . .	B-85
B-83	Panel 1-14A-1 Residual Compression Data . . . . .	B-86
B-84	Panel 1-19-2 First Impact Response Data . . . . .	B-87
B-85	Panel 1-19-2 Second Impact Response Data . . . . .	B-88
B-86	Panel 1-19-2 C-scan . . . . .	B-89
B-87	Panel 1-19-2 Residual Compression Data . . . . .	B-90
B-88	Panel 2-16-1 Impact Response Data . . . . .	B-91
B-89	Panel 2-16-1 C-scan . . . . .	B-92
B-90	Panel 2-16-1 Residual Compression Data . . . . .	B-93
B-91	Panel 2-12A-1 Impact Response Data . . . . .	B-94
B-92	Panel 2-12A-1 C-scan . . . . .	B-95
B-93	Panel 2-12A-1 Residual Compression Data . . . . .	B-96
B-94	Panel 2-17-2 Impact Response Data . . . . .	B-97
B-95	Panel 2-17-2 C-scan . . . . .	B-98

# LIST OF FIGURES (Continued)

<u>Figure</u>		<u>Page</u>
B-96	Panel 2-17-2 Residual Compression Data . . . . .	B-99
B-97	Panel 2-18-2 Impact Response Data . . . . .	B-100
B-98	Panel 2-18-2 C-scan . . . . .	B-101
B-99	Panel 2-18-2 Residual Compression Data . . . . .	B-102
B-100	Panel 2-14A-1 First Impact Response Data . . . . .	B-103
B-101	Panel 2-14A-1 Second Impact Response Data . . . . .	B-104
B-102	Panel 2-14A-1 C-scan . . . . .	B-105
B-103	Panel 2-14A-1 Residual Compression Data . . . . .	B-106
B-104	Panel 2-19-2 First Impact Response Data . . . . .	B-107
B-105	Panel 2-19-2 Second Impact Response Data . . . . .	B-108
B-106	Panel 2-19-2 C-scan . . . . .	B-109
B-107	Panel 2-19-2 Residual Compression Data . . . . .	B-110
B-108	Panel 1-16-4 Impact Response Data . . . . .	B-111
B-109	Panel 1-16-4 Residual Compression Data . . . . .	B-112
B-110	Panel 1-12A-5 Impact Response Data . . . . .	B-113
B-111	Panel 1-12A-5 Residual Compression Data . . . . .	B-114
B-112	Panel 1-17-5 Impact Response Data . . . . .	B-115
B-113	Panel 1-17-5 Residual Compression Data . . . . .	B-116
B-114	Panel 1-18-6 Impact Response Data . . . . .	B-117
B-115	Panel 1-18-6 Residual Compression Data . . . . .	B-118
B-116	Panel 1-14A-4 Impact Response Data . . . . .	B-119
B-117	Panel 1-14A-4 Residual Compression Data . . . . .	B-120
B-118	Panel 1-19-5 First Impact Response Data . . . . .	B-121
B-119	Panel 1-19-5 Second Impact Response Data . . . . .	B-122
B-120	Panel 1-19-5 Residual Compression Data . . . . .	B-123
B-121	Panel 2-16-5 Impact Response Data . . . . .	B-124
B-122	Panel 2-16-5 Residual Compression Data . . . . .	B-125
B-123	Panel 2-12A-4 Impact Response Data . . . . .	B-126
B-124	Panel 2-12A-4 Residual Compression Data . . . . .	B-127
B-125	Panel 2-17-6 Impact Response Data . . . . .	B-128
B-126	Panel 2-17-6 Residual Compression Data . . . . .	B-129
B-127	Panel 2-18-5 Impact Response Data . . . . .	B-130

# LIST OF FIGURES (Continued)

<u>Figure</u>		<u>Page</u>
B-128	Panel 2-18-5 Residual Compression Data . . . . .	B-131
B-129	Panel 2-14A-5 First Impact Response Data . . . . .	B-132
B-130	Panel 2-14A-5 Second Impact Response Data . . . . .	B-133
B-131	Panel 2-14A-5 Residual Compression Data . . . . .	B-134
B-132	Panel 2-19-6 Impact Response Data . . . . .	B-135
B-133	Panel 2-19-6 Residual Compression Data . . . . .	B-136
B-134	Visible Impact Damage Data Table . . . . .	B-138
B-135	Panel 1-12-8 Impact Response Data . . . . .	B-139
B-136	Panel 1-12-8 C-scan . . . . .	B-140
B-137	Panel 1-12-8 Residual Compression Data . . . . .	B-141
B-138	Panel 1-11-8 Impact Response Data . . . . .	B-142
B-139	Panel 1-11-8 C-scan . . . . .	B-143
B-140	Panel 1-11-8 Residual Compression Data . . . . .	B-144
B-141	Panel 1-13-8 Impact Response Data . . . . .	B-145
B-142	Panel 1-13-8 C-scan . . . . .	B-146
B-143	Panel 1-13-8 Residual Compression Data . . . . .	B-147
B-144	Panel 1-14-9 Impact Response Data . . . . .	B-148
B-145	Panel 1-14-9 C-scan . . . . .	B-149
B-146	Panel 1-14-9 Residual Compression Data . . . . .	B-150
B-147	Panel 1-20-8 Impact Response Data . . . . .	B-151
B-148	Panel 1-20-8 C-scan . . . . .	B-152
B-149	Panel 1-20-8 Residual Compression Data . . . . .	B-153
B-150	Panel 1-15-7 Impact Response Data . . . . .	B-154
B-151	Panel 1-15-7 C-scan . . . . .	B-155
B-152	Panel 1-15-7 Residual Compression Data . . . . .	B-156
B-153	Panel 2-12-9 Impact Response Data . . . . .	B-157
B-154	Panel 2-12-9 C-scan . . . . .	B-158
B-155	Panel 2-12-9 Residual Compression Data . . . . .	B-159
B-156	Panel 2-11-9 Impact Response Data . . . . .	B-160
B-157	Panel 2-11-9 C-scan . . . . .	B-161
B-158	Panel 2-11-9 Residual Compression Data . . . . .	B-162
B-159	Panel 2-13-7 Impact Response Data . . . . .	B-163

# LIST OF FIGURES (Continued)

<u>Figure</u>		<u>Page</u>
B-160	Panel 2-13-7 C-scan . . . . .	B-164
B-161	Panel 2-13-7 Residual Compression Data . . . . .	B-165
B-162	Panel 2-14-8 Impact Response Data . . . . .	B-166
B-163	Panel 2-14-8 C-scan . . . . .	B-167
B-164	Panel 2-14-8 Residual Compression Data . . . . .	B-168
B-165	Panel 2-20-7 Impact Response Data . . . . .	B-169
B-166	Panel 2-20-7 C-scan . . . . .	B-170
B-167	Panel 2-20-7 Residual Compression Data . . . . .	B-171
B-168	Panel 2-15-8 Impact Response Data . . . . .	B-172
B-169	Panel 2-15-8 C-scan . . . . .	B-173
B-170	Panel 2-15-8 Residual Compression Data . . . . .	B-174
B-171	Panel 1-12-12 Impact Response Data . . . . .	B-175
B-172	Panel 1-12-12 Residual Compression Data . . . . .	B-176
B-173	Panel 1-11-12 Impact Response Data . . . . .	B-177
B-174	Panel 1-11-12 Residual Compression Data . . . . .	B-178
B-175	Panel 1-13-12 Impact Response Data . . . . .	B-179
B-176	Panel 1-13-12 Residual Compression Data . . . . .	B-180
B-177	Panel 1-14-11 Impact Response Data . . . . .	B-181
B-178	Panel 1-14-11 Residual Compression Data . . . . .	B-182
B-179	Panel 1-20-11 Impact Response Data . . . . .	B-183
B-180	Panel 1-20-11 Residual Compression Data . . . . .	B-184
B-181	Panel 1-15-11 Impact Response Data . . . . .	B-185
B-182	Panel 1-15-11 Residual Compression Data . . . . .	B-186
B-183	Panel 2-12-11 Impact Response Data . . . . .	B-187
B-184	Panel 2-12-11 Residual Compression Data . . . . .	B-188
B-185	Panel 2-11-11 Impact Response Data . . . . .	B-189
B-186	Panel 2-11-11 Residual Compression Data . . . . .	B-190
B-187	Panel 2-13-11 Impact Response Data . . . . .	B-191
B-188	Panel 2-13-11 Residual Compression Data . . . . .	B-192
B-189	Panel 2-14-11 Impact Response Data . . . . .	B-193
B-190	Panel 2-14-11 Residual Compression Data . . . . .	B-194
B-191	Panel 2-20-12 Impact Response Data . . . . .	B-195

LIST OF FIGURES (Concluded)

<u>Figure</u>		<u>Page</u>
B-192	Panel 2-20-12 Residual Compression Data . . . . .	B-196
B-193	Panel 2-15-10 Impact Response Data . . . . .	B-197
B-194	Panel 2-15-10 Residual Compression Data . . . . .	B-198

## APPENDIX A

### CRACK GROWTH PLOTS

## A.1 CTD DATA

MODE I CRACK GROWTH DATA  
IM6/3100 -- CTD ENVIRONMENT

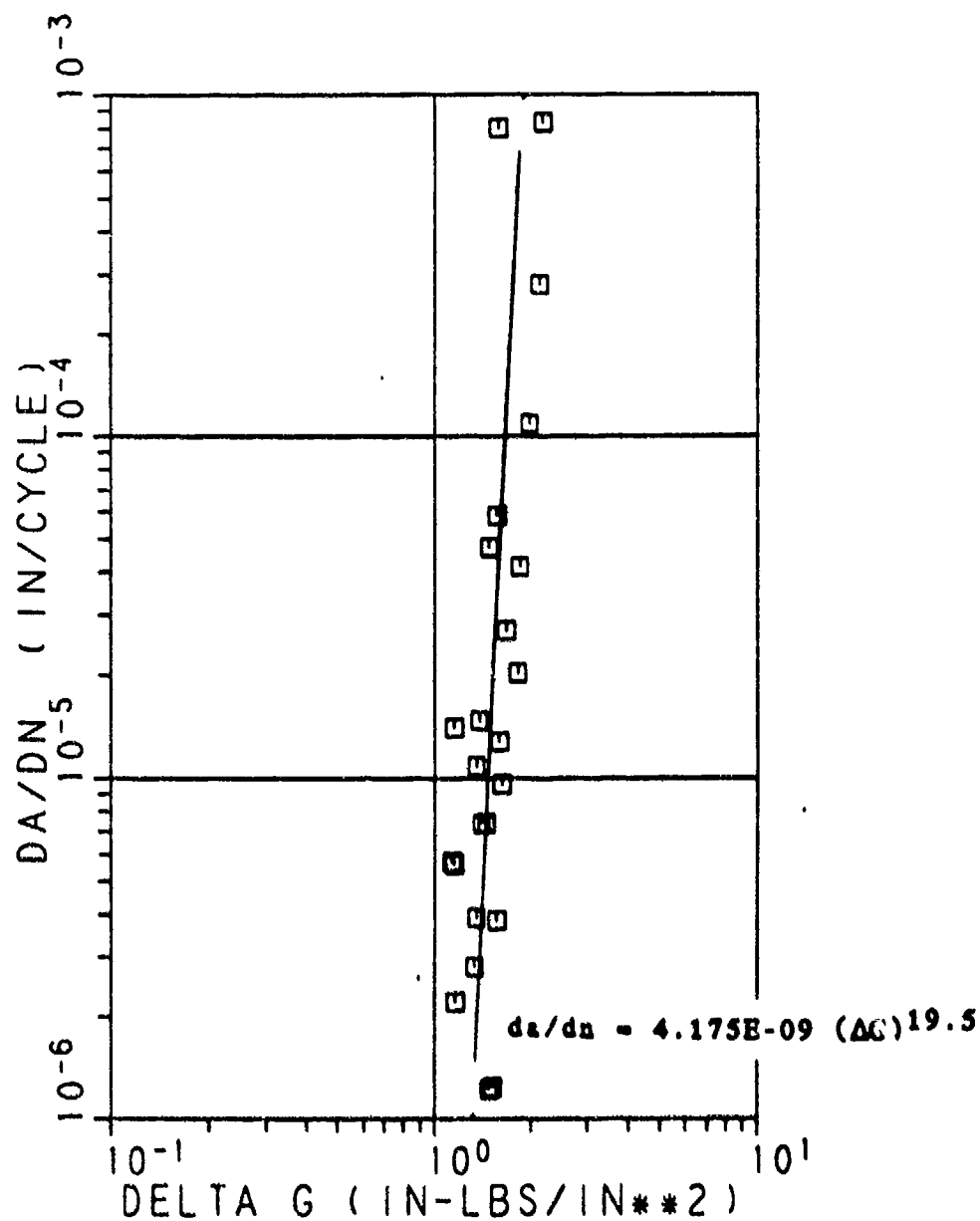


Figure A-1. IM6/3100 Mode I at CTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-63  
IM6/3100 -- CTD ENVIRONMENT

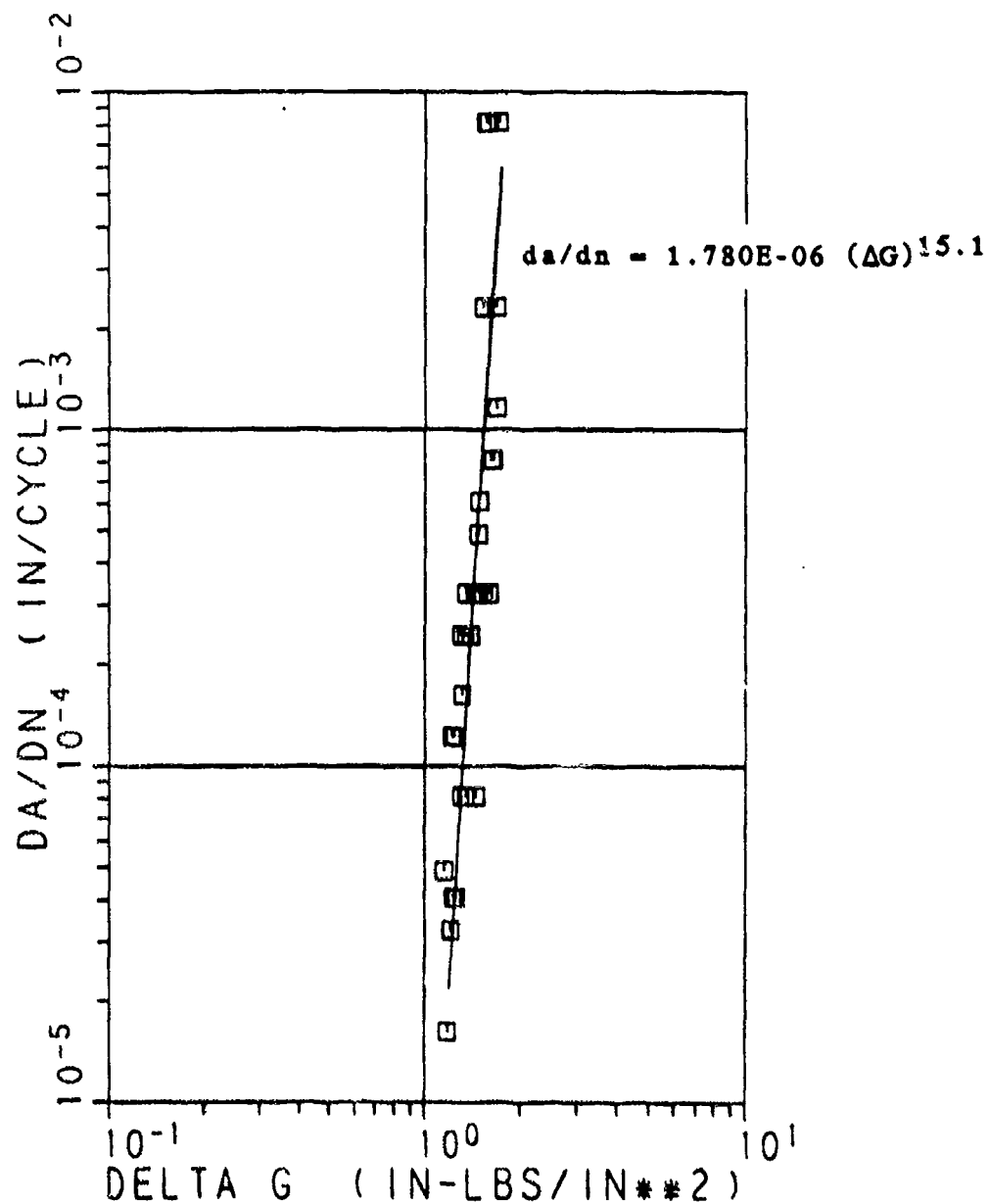


Figure A-2. IM6/3100 Mixed Mode (CLS-63) at CTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-82  
IM6/3100 -- CTD ENVIRONMENT

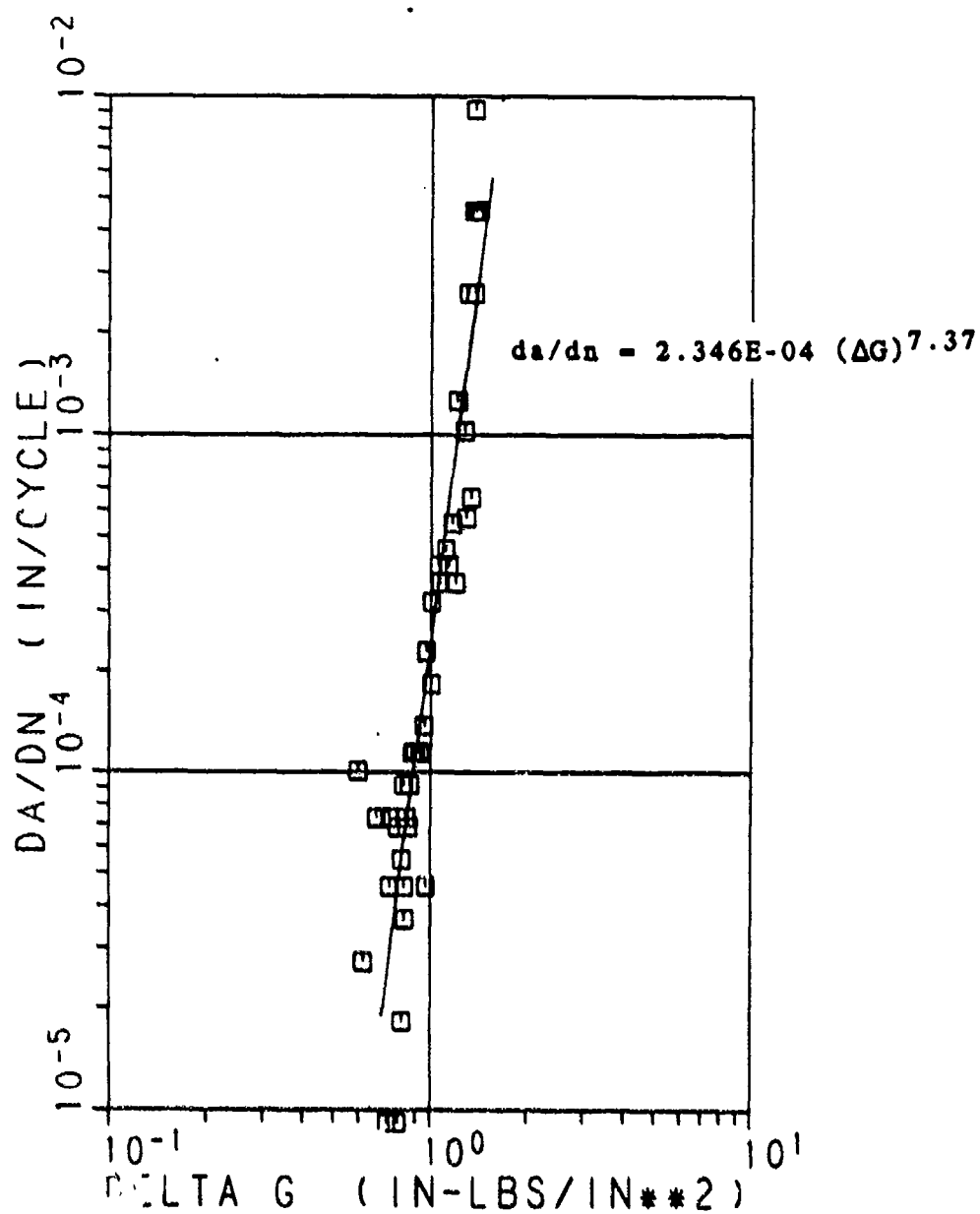


Figure A-3. IM6/3100 Mixed Mode (CLS-82) at CTD Conditions

MODE II CRACK GROWTH DATA  
IM6/3100 -- CTD ENVIRONMENT

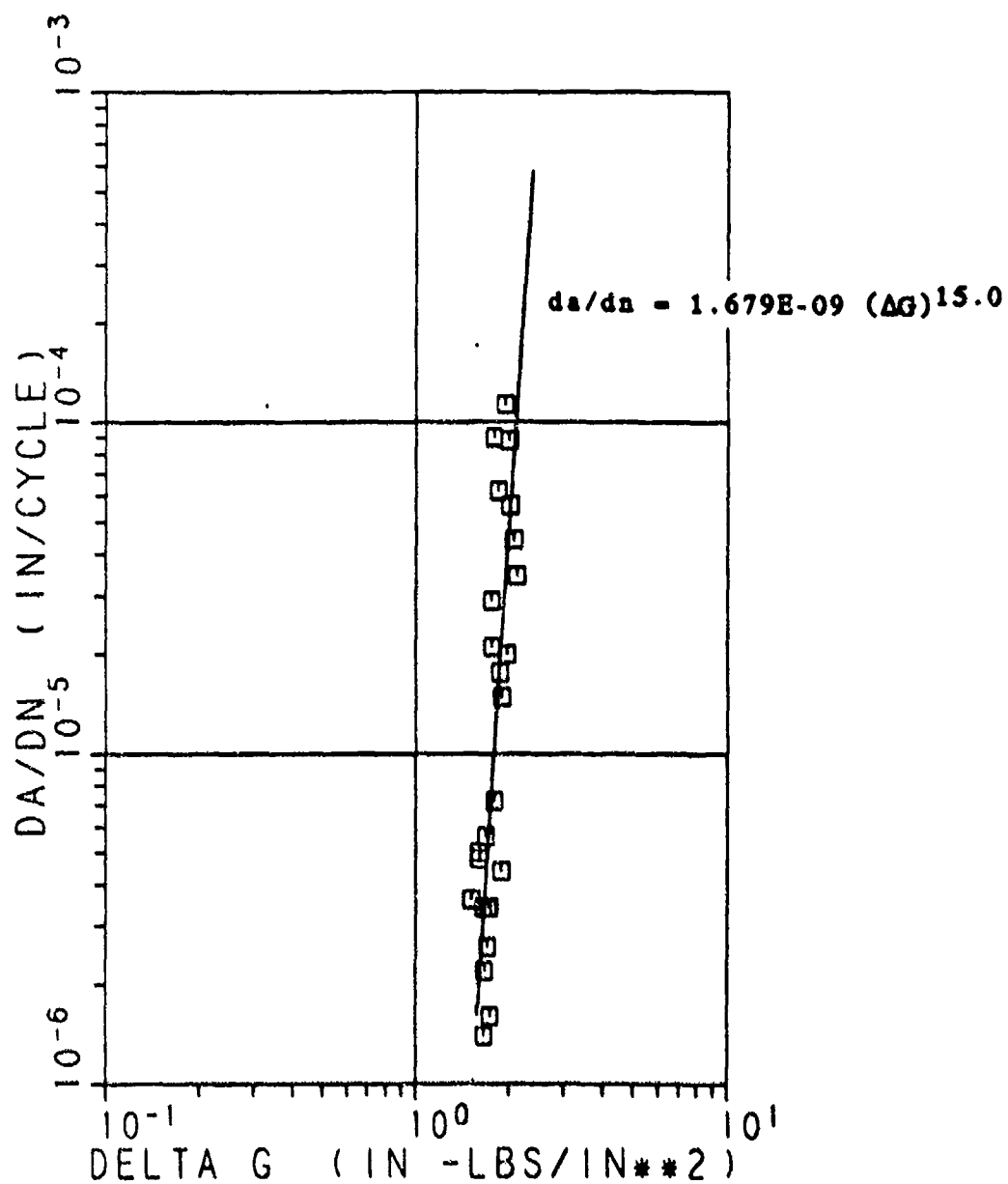


Figure A-4. IM6/3100 Mode II at CTD Conditions

MODE I CRACK GROWTH DATA  
IM6/F650 -- CTD ENVIRONMENT

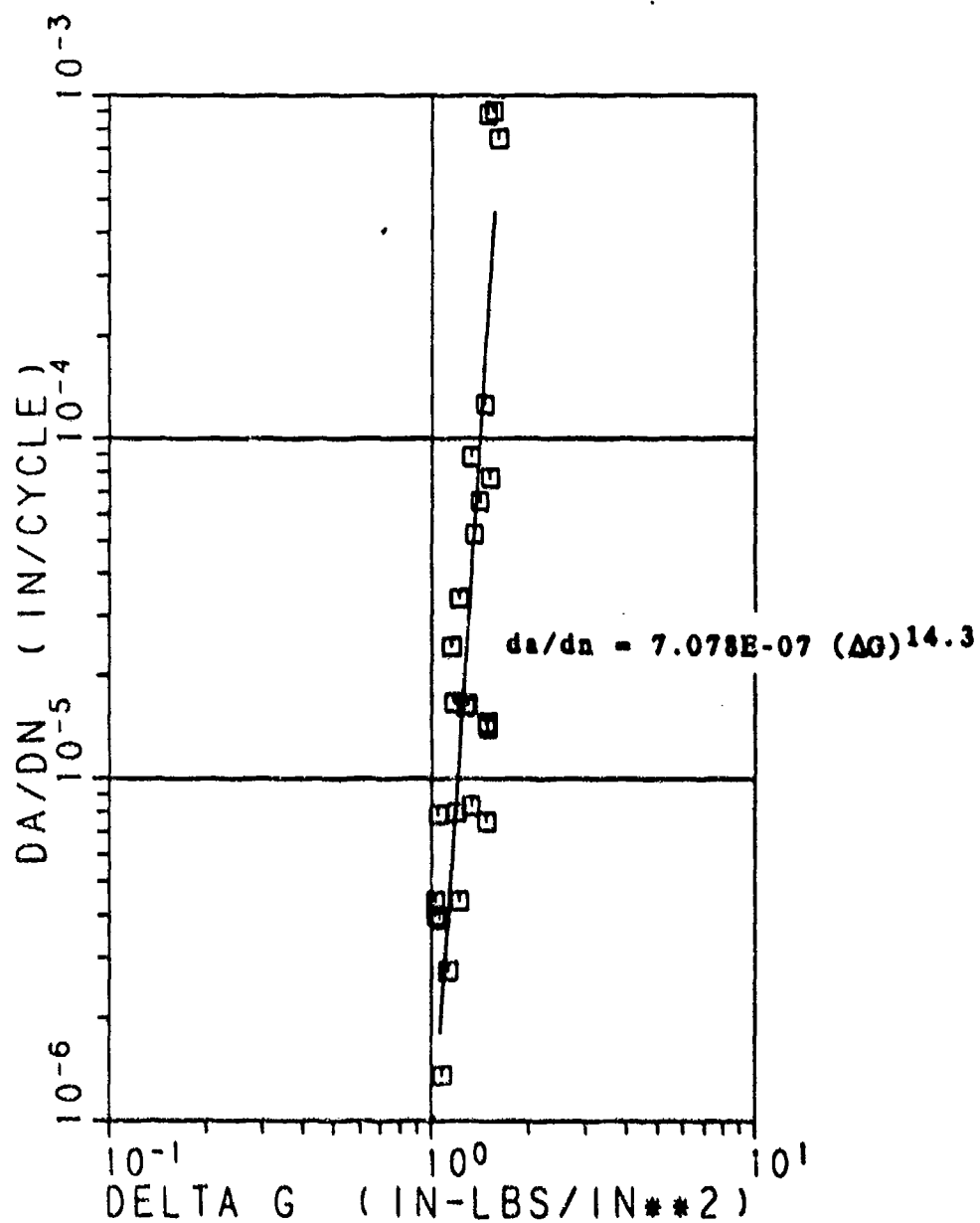


Figure A-5. IM6/F650 Mode I at CTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-63  
IM6/F650 -- CTD ENVIRONMENT

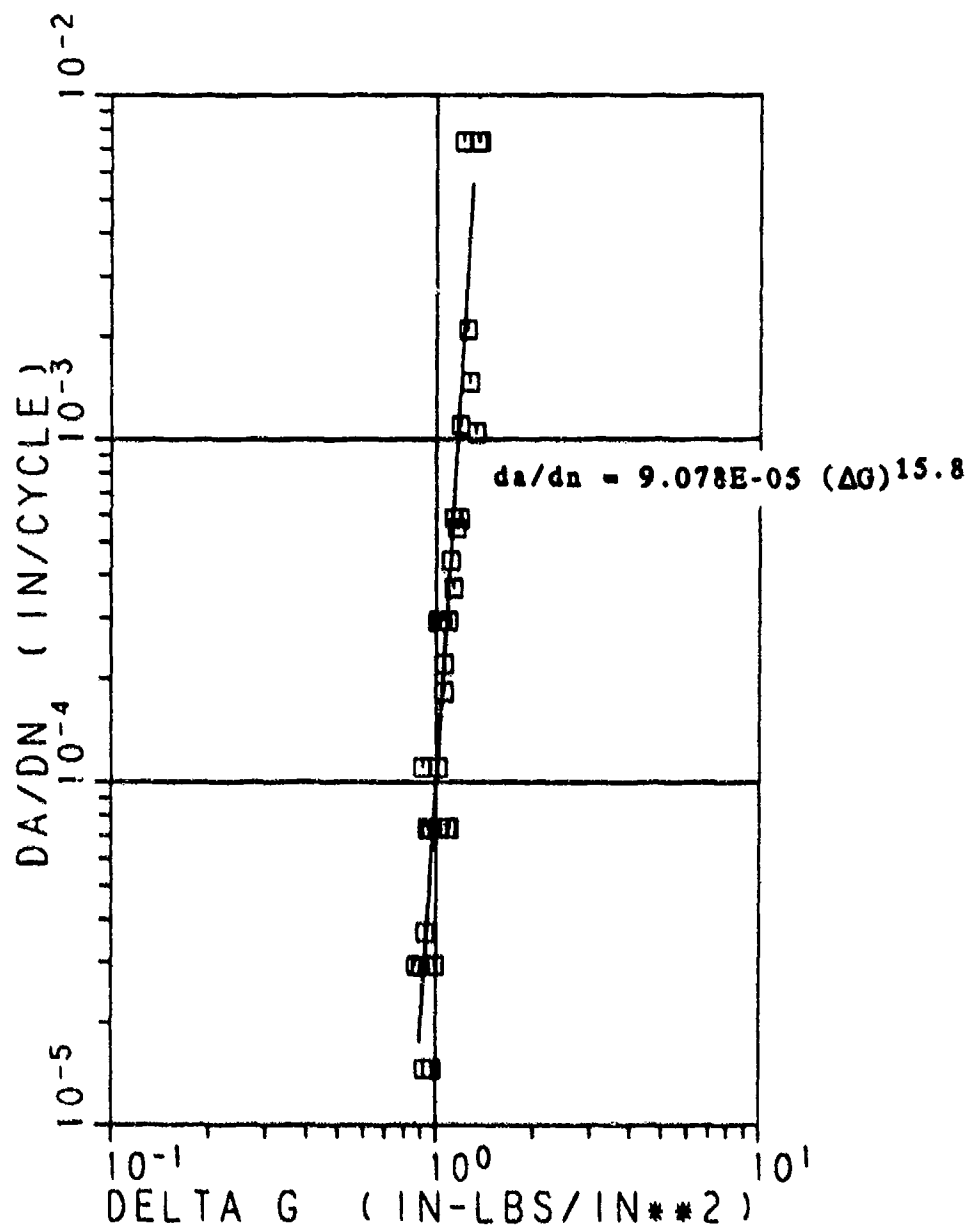


Figure A-8. IM6/F650 Mixed Mode (CLS-63) at CTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-82  
IM6/F650 -- CTD ENVIRONMENT

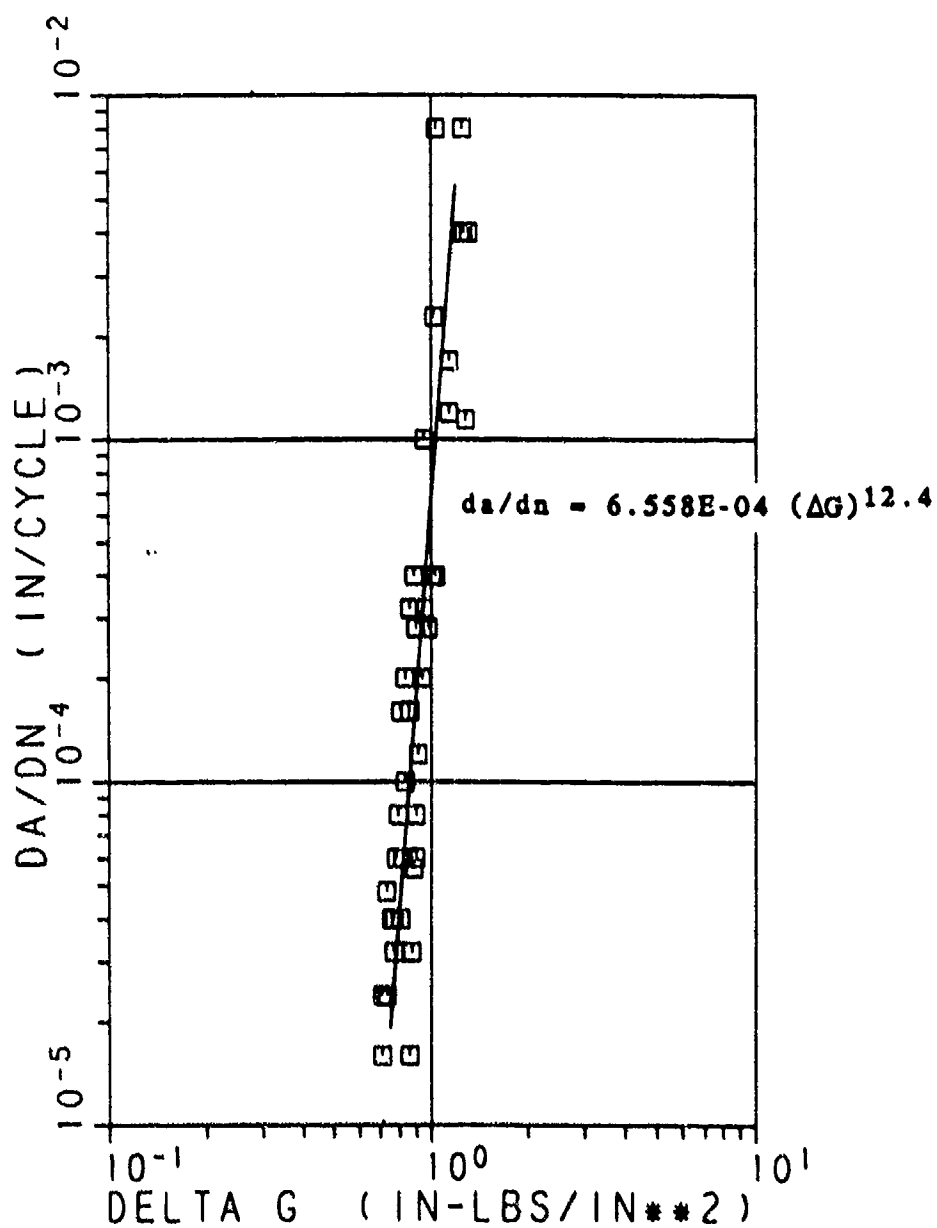


Figure A-7. IM6/F650 Mixed Mode (CLS-82) at CTD Conditions

MODE II CRACK GROWTH DATA  
IM6/F650 -- CTD ENVIRONMENT

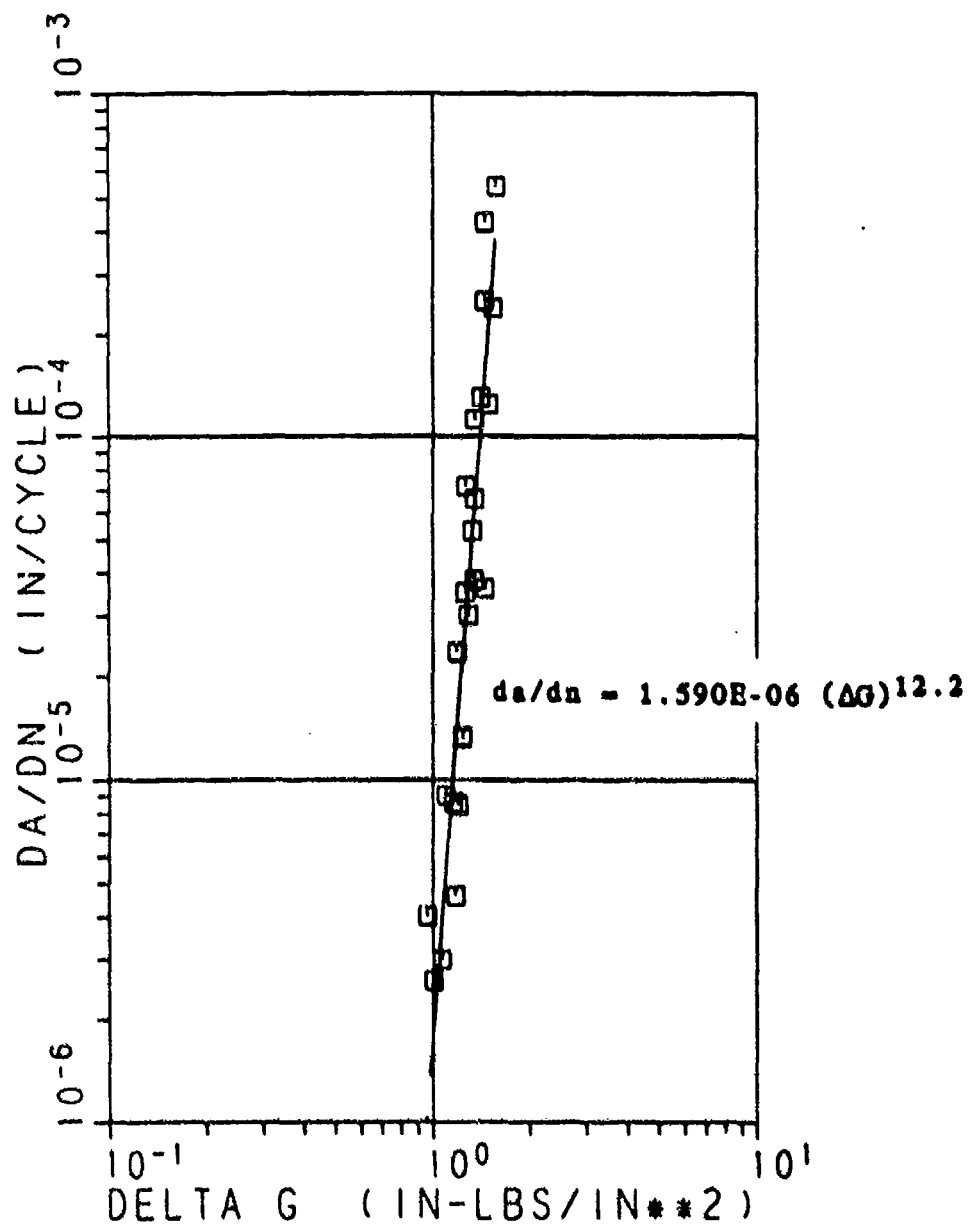


Figure A-8. IM6/F650 Mode II at CTD Conditions

## A.2 RTD DATA

MODE I CRACK GROWTH DATA  
IM6/3100 -- RTD ENVIRONMENT

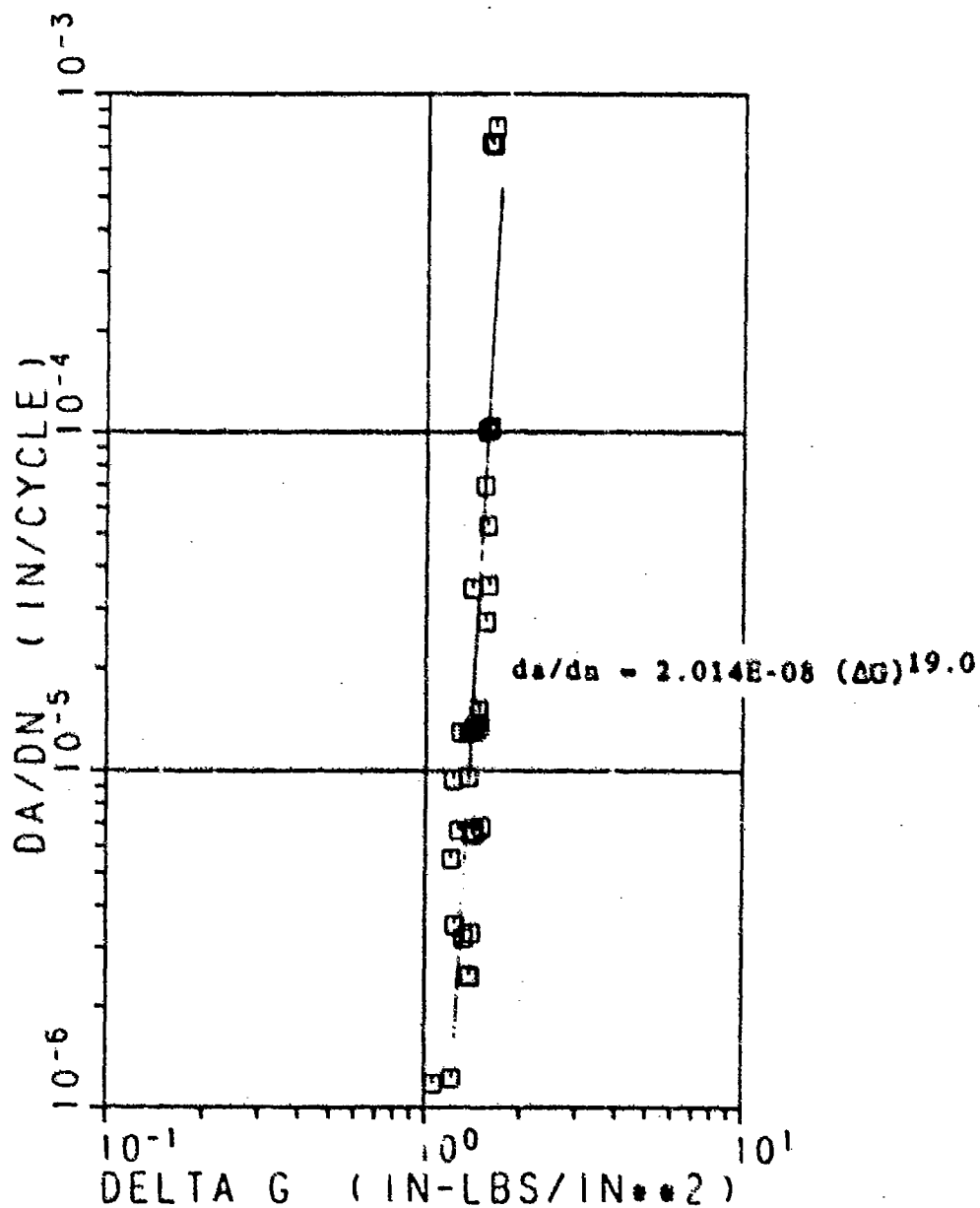


Figure A-9. IM6/3100 Mode I at RTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-63  
IM6/3100 -- RTD ENVIRONMENT

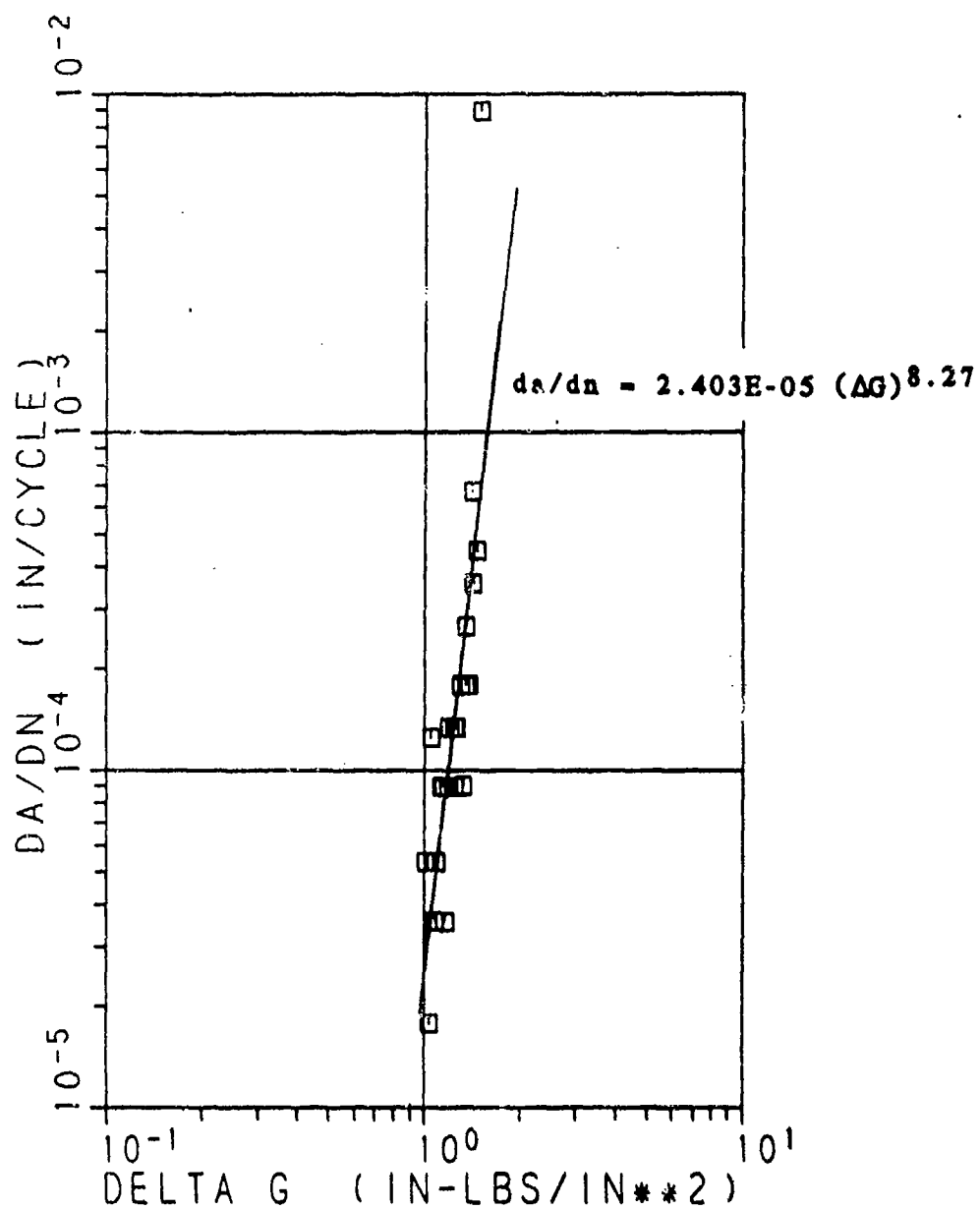


Figure A-10. IM6/3100 Mixed Mode (CLS-63) at RTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-82  
 IM6/3100 -- RTD ENVIRONMENT

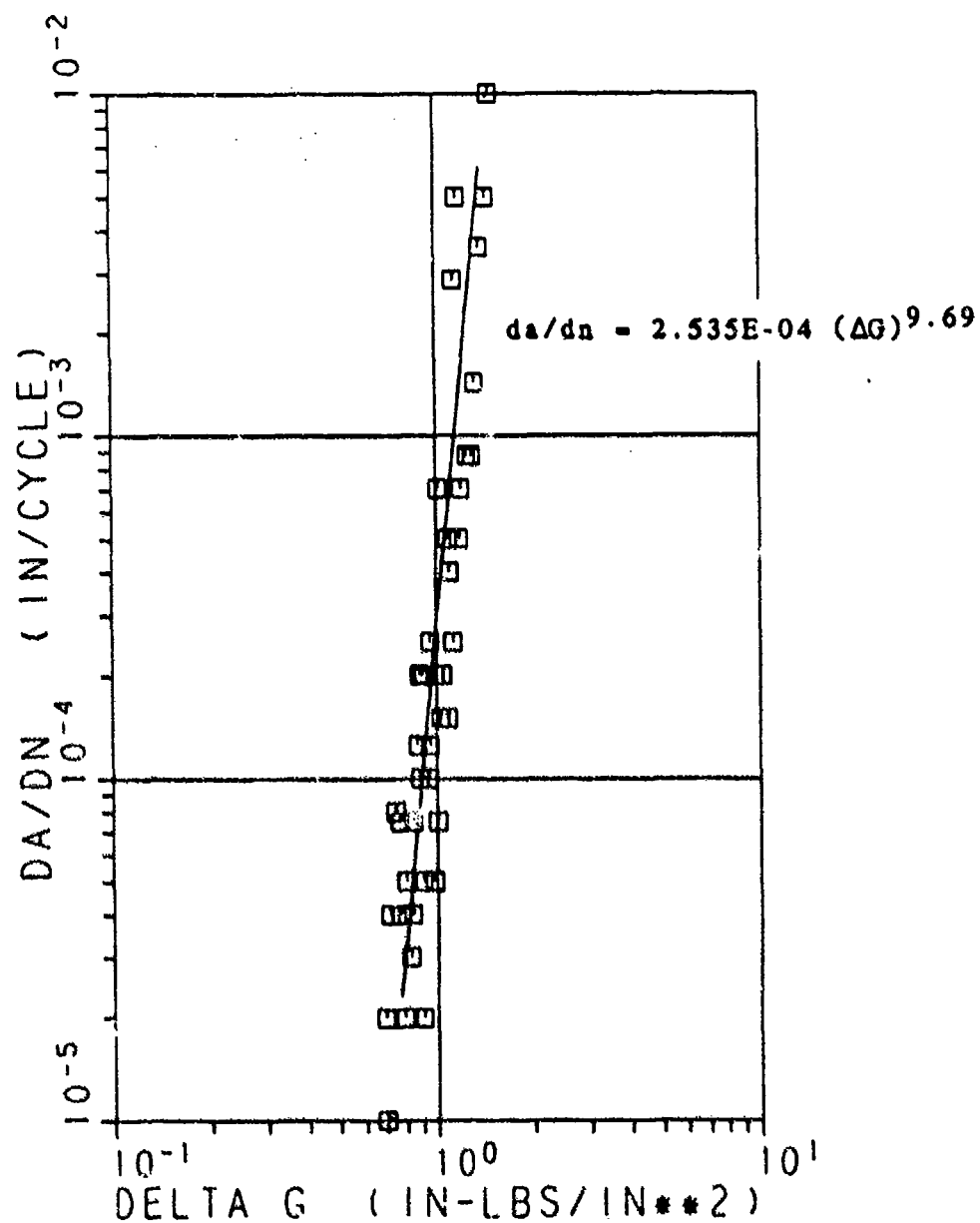


Figure A-11. IM6/3100 Mixed Mode (CLS-82) at RTD Conditions

MODE II CRACK GROWTH DATA  
IM6/3100 -- RTD ENVIRONMENT

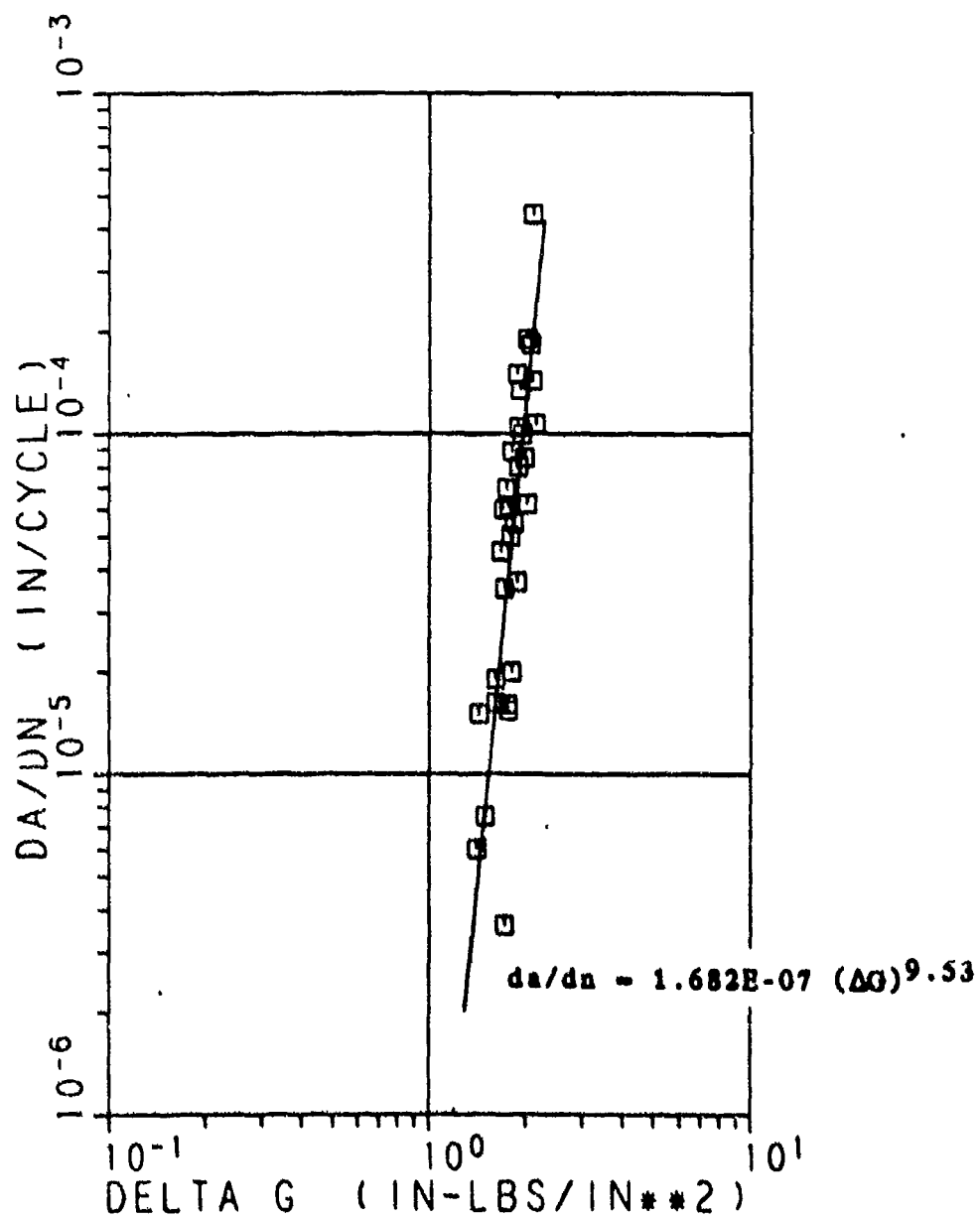


Figure A-12. IM6/3100 Mode II at RTD Conditions

MODE I CRACK GROWTH DATA  
IM6/F650 -- RTD ENVIRONMENT

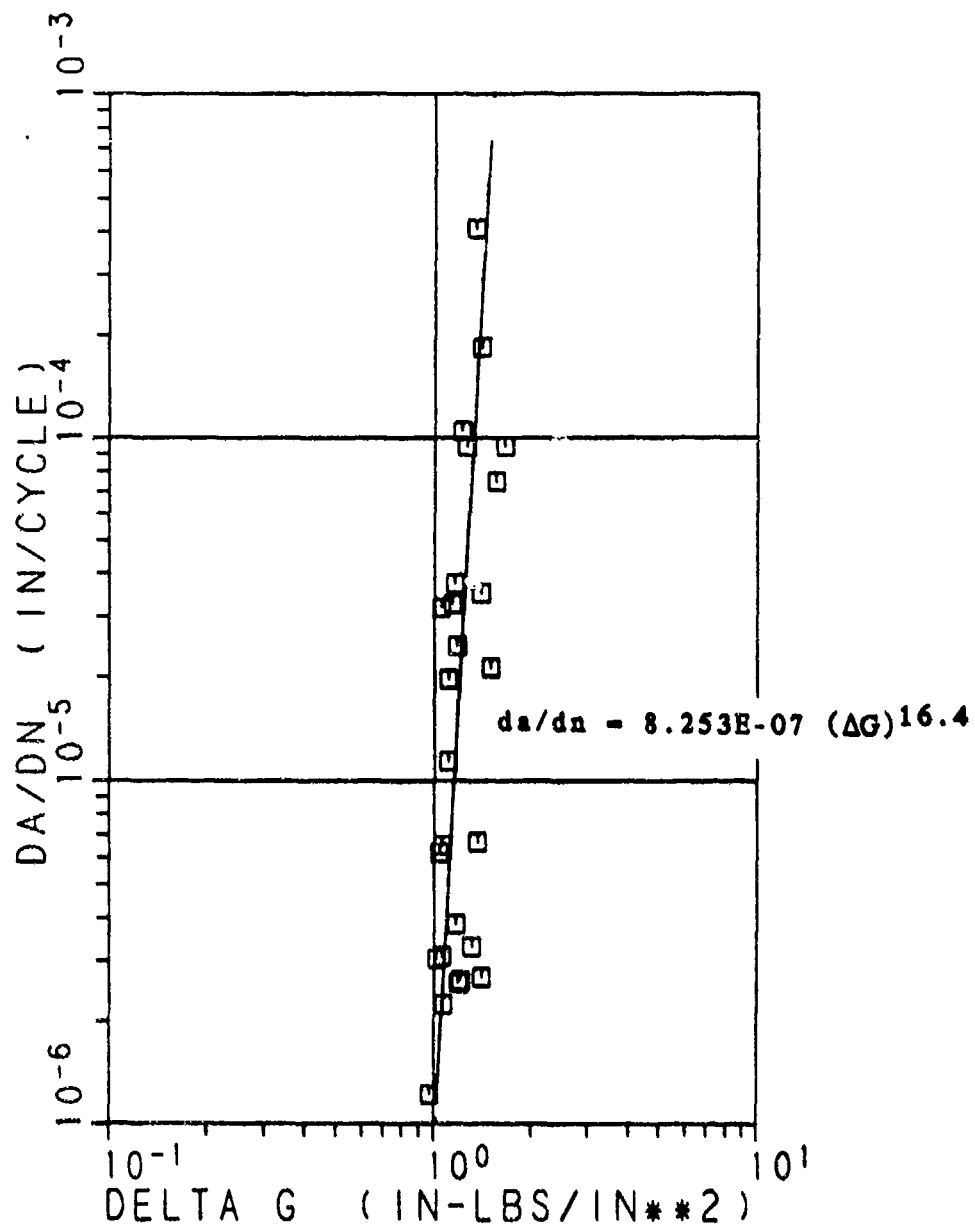


Figure A-13. IM6/F650 Mode I at RTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-63  
IM6/F650 -- RTD ENVIRONMENT

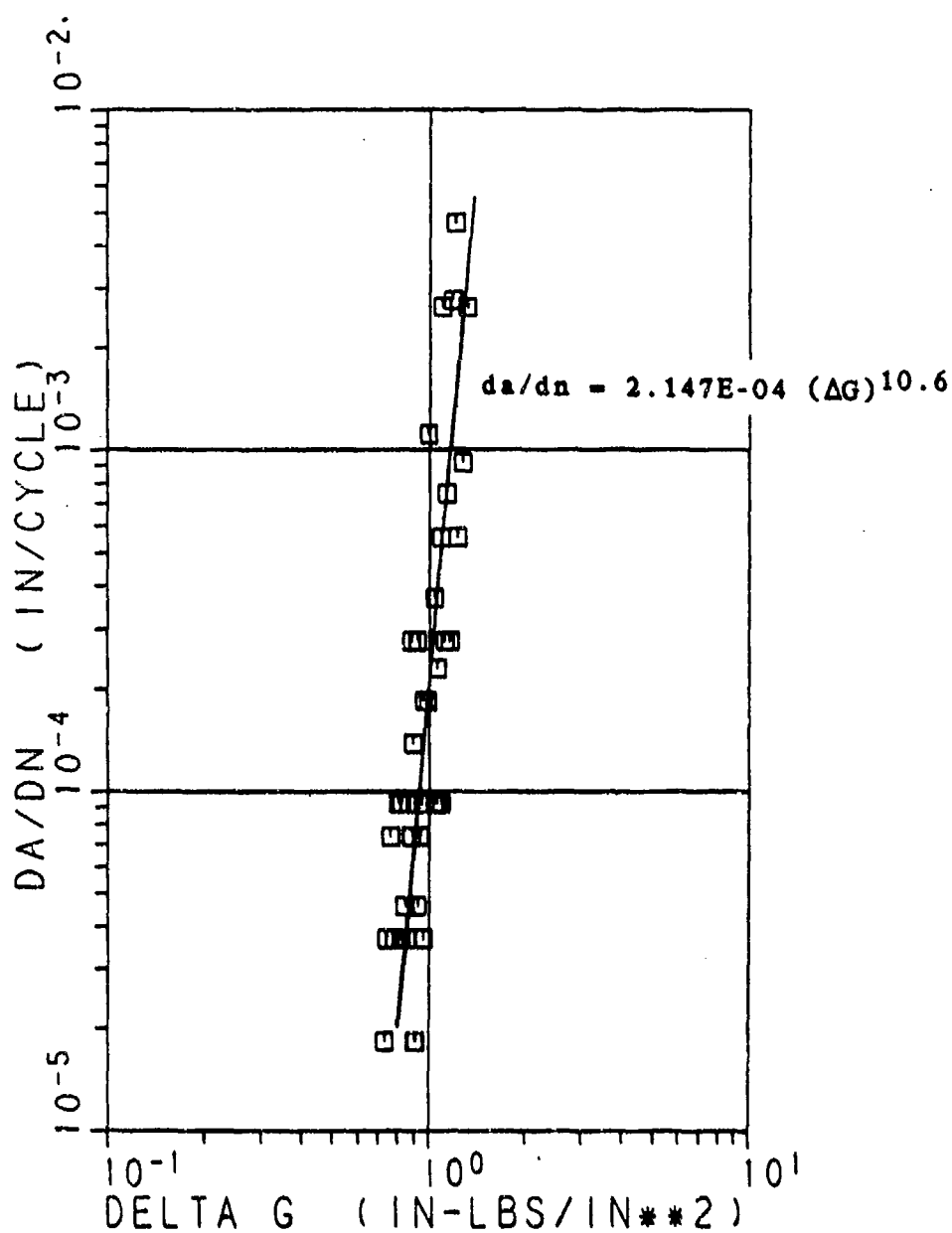


Figure A-14. IM6/F650 Mixed Mode (CLS-63) at RTD Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-82  
 IM6/F650 -- RTD ENVIRONMENT

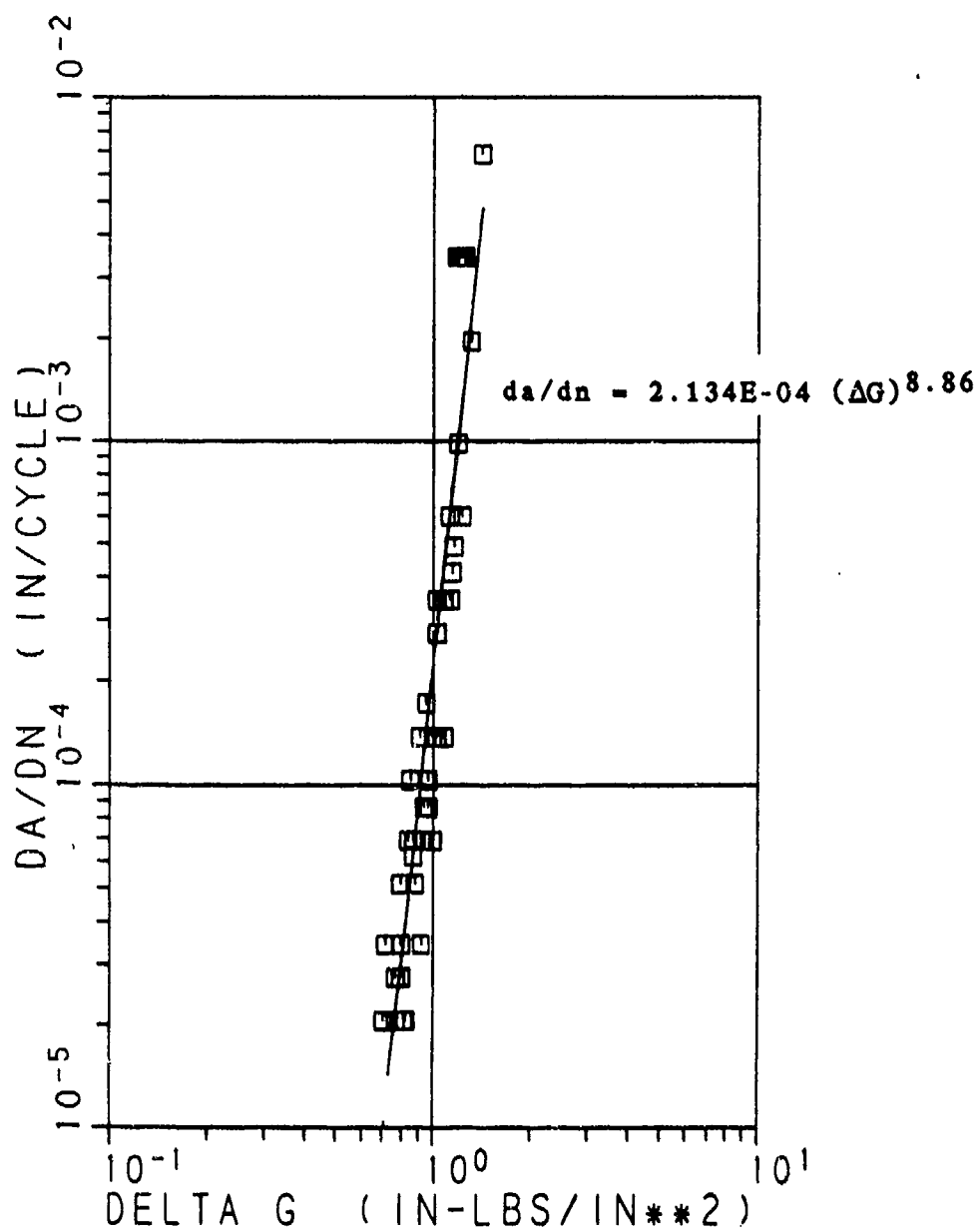


Figure A-15. IM6/F650 Mixed Mode (CLS-82) at RTD Conditions

MODE II CRACK GROWTH DATA  
IM6/F650 -- RTD ENVIRONMENT

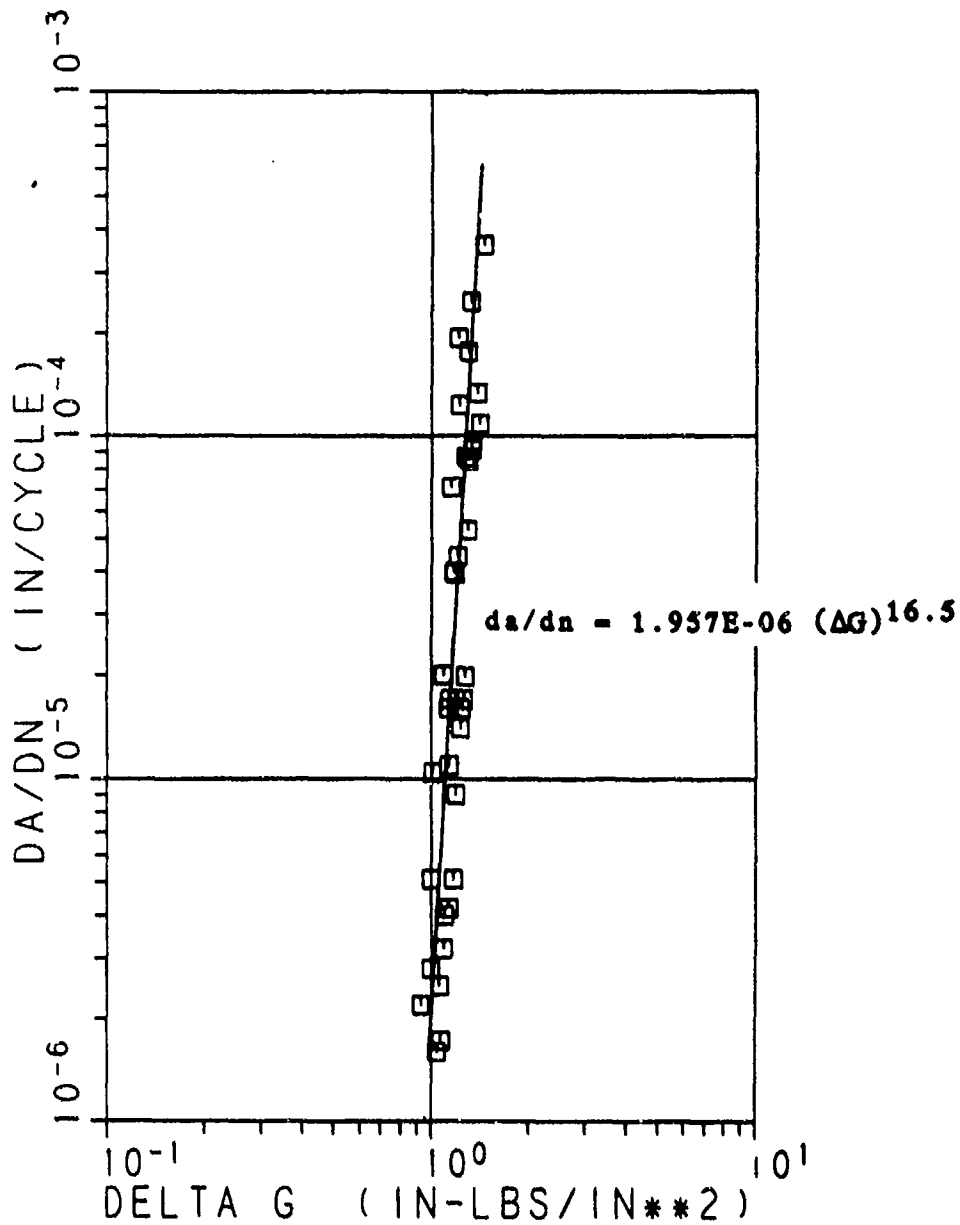


Figure A-16. IM6/F650 Mode II at RTD Conditions

### A.3 ETW DATA

MODE I CRACK GROWTH DATA  
IM6/3100 -- ETW ENVIRONMENT

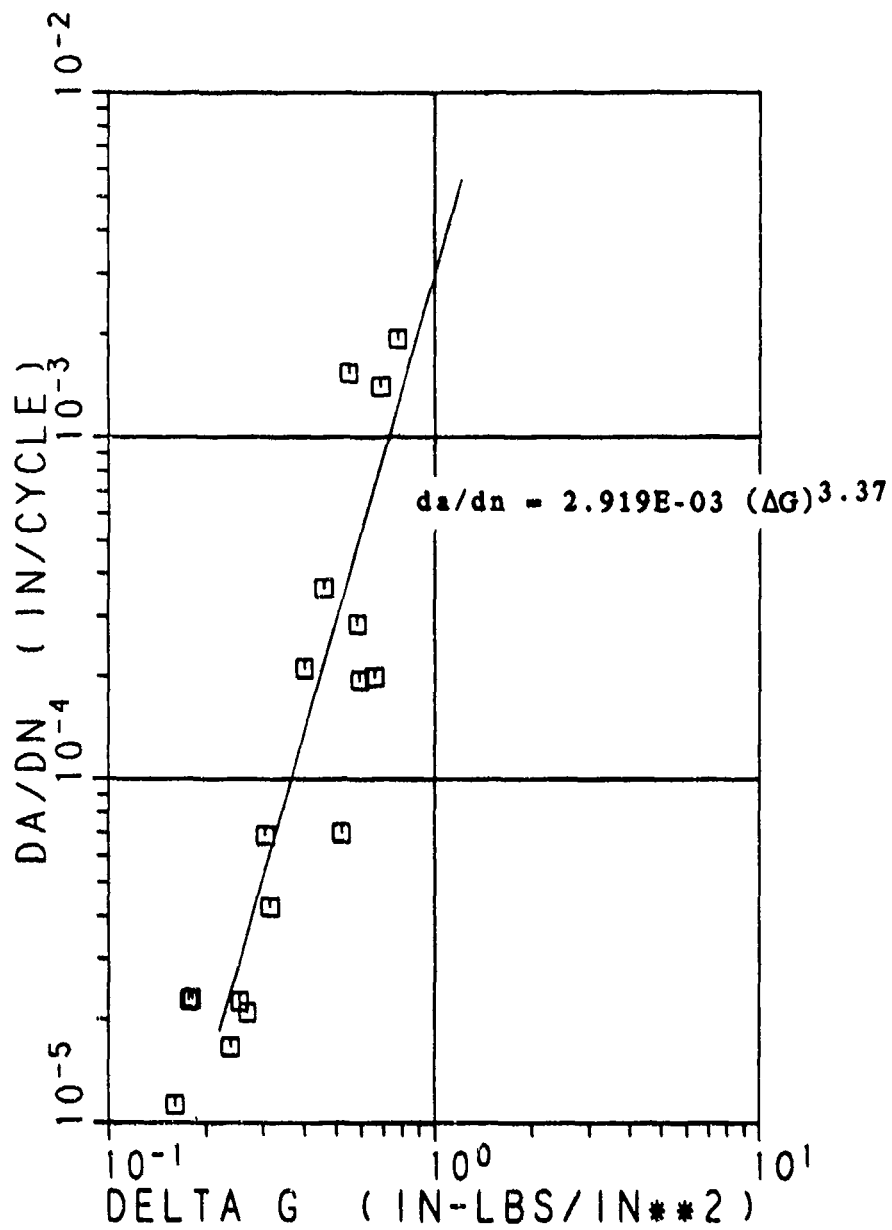


Figure A-17. IM6/3100 Mode I at ETW Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-63  
IM6/3100 -- ETW ENVIRONMENT

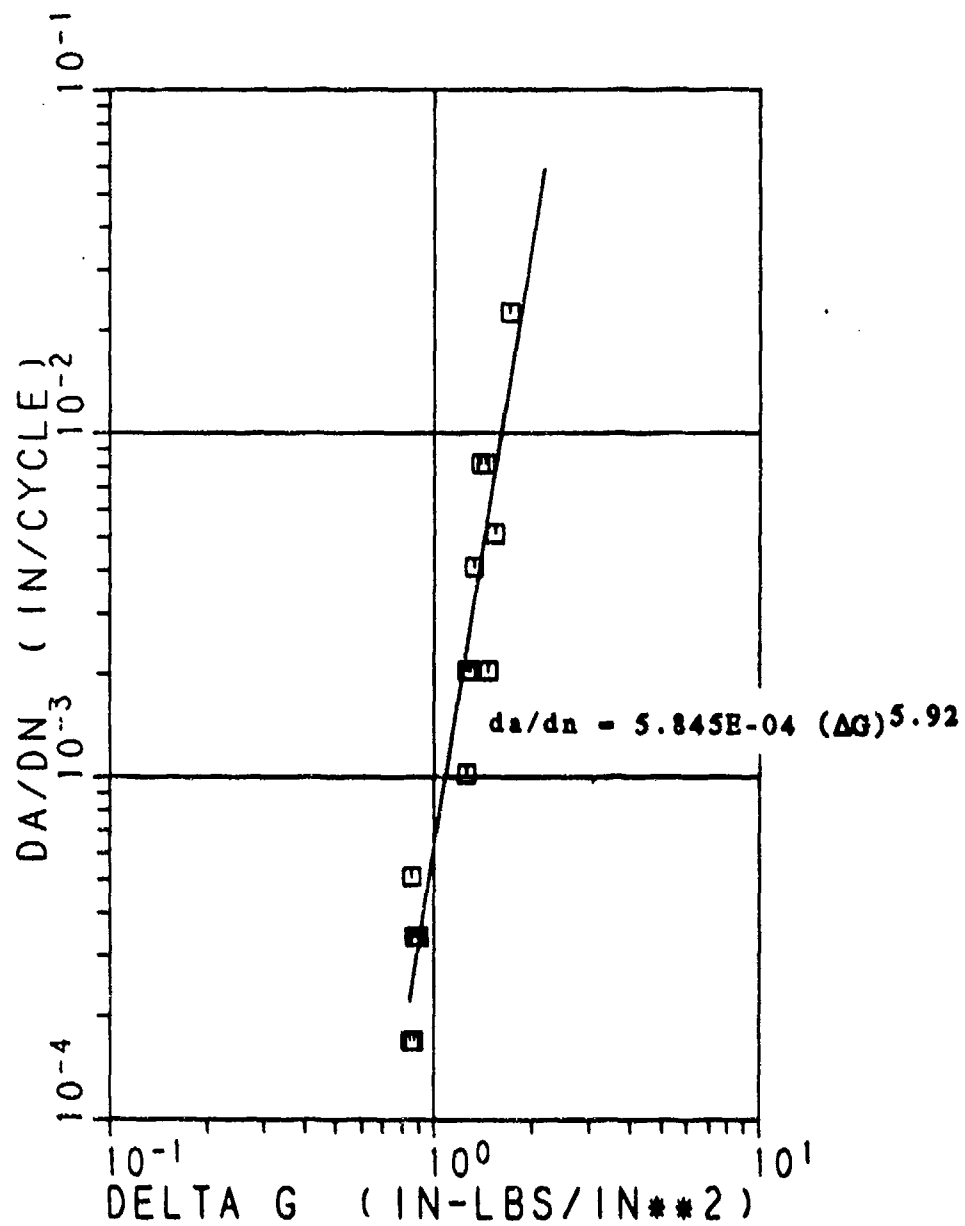


Figure A-18. IM6/3100 Mixed Mode (CLS-63) at ETW Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-82  
IM6/3100 -- ETW ENVIRONMENT

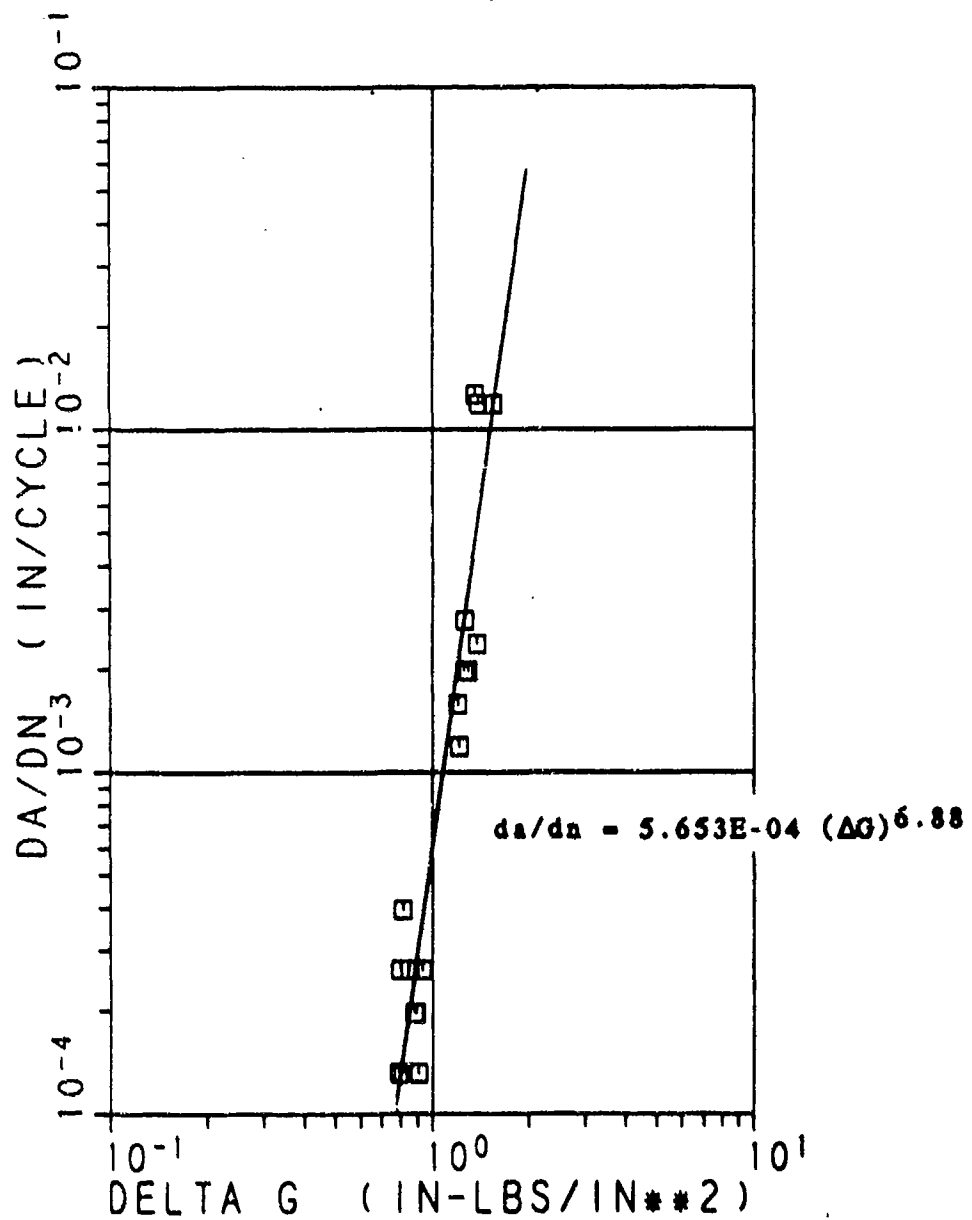


Figure A-19. IM6/3100 Mixed Mode (CLS-82) at ETW Conditions

MODE II CRACK GROWTH DATA  
IM6/3100 -- ETW ENVIRONMENT

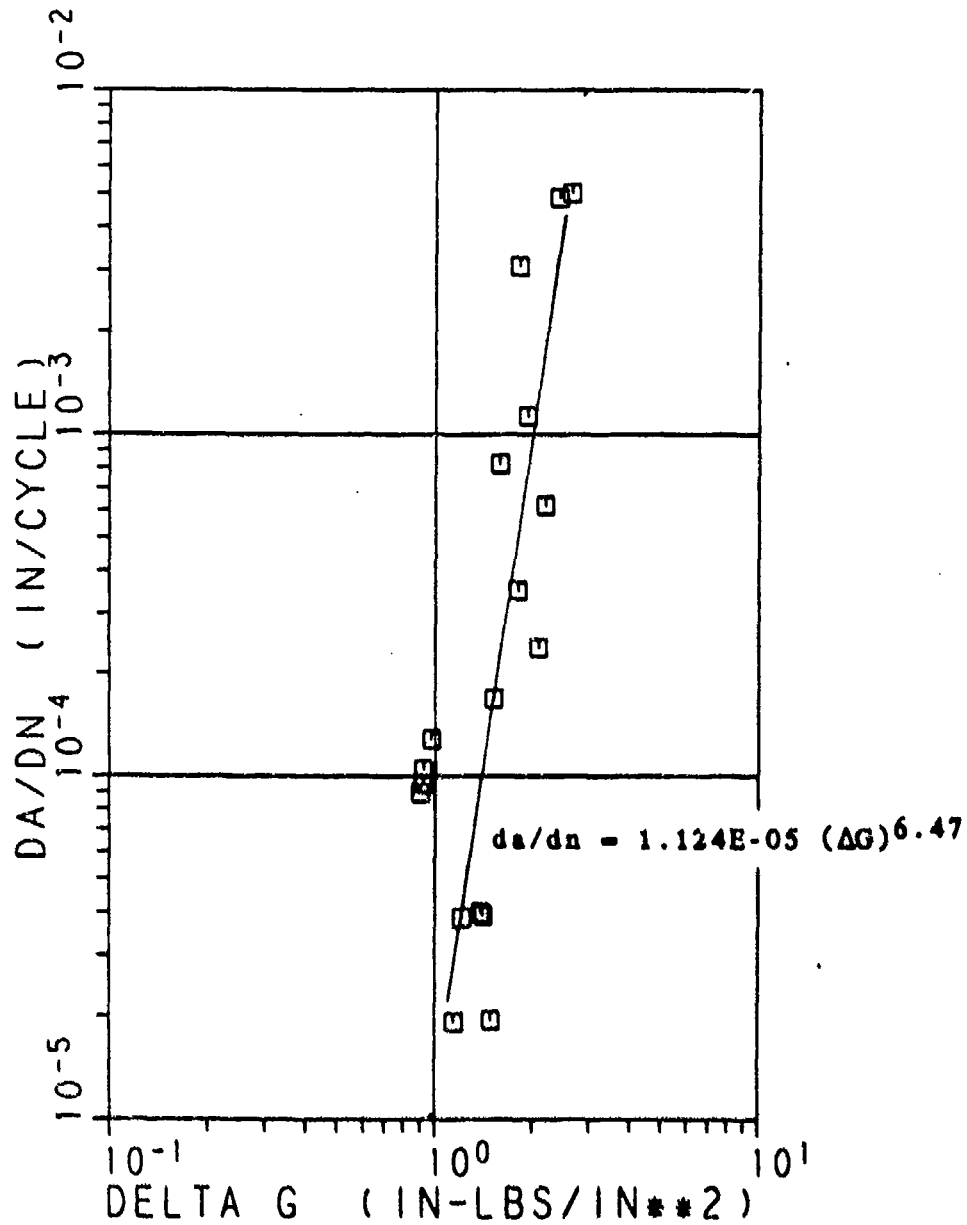


Figure A-20. IM6/3100 Mode II at ETW Conditions

MODE I CRACK GROWTH DATA  
IM6/F650 -- ETW ENVIRONMENT

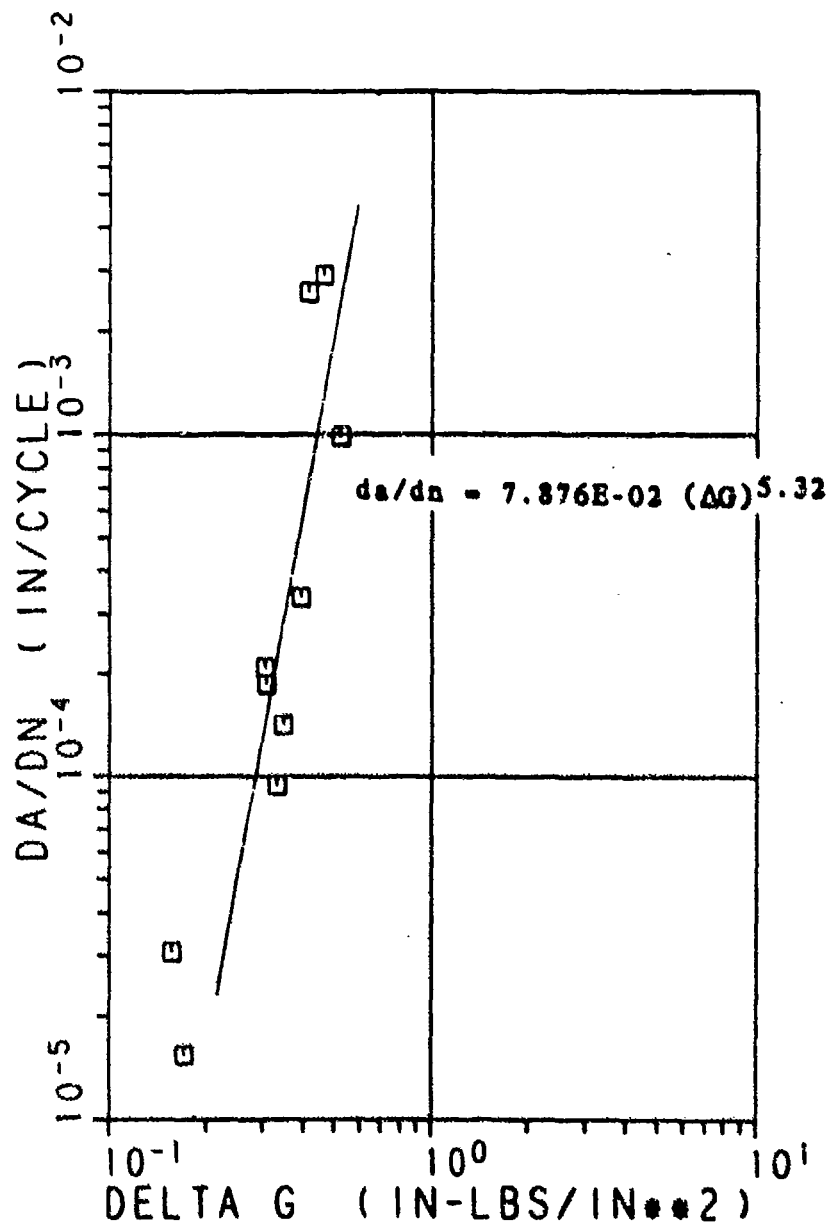


Figure A-21. IM6/F650 Mode I at ETW Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-63  
IM6/F650 -- ETW ENVIRONMENT

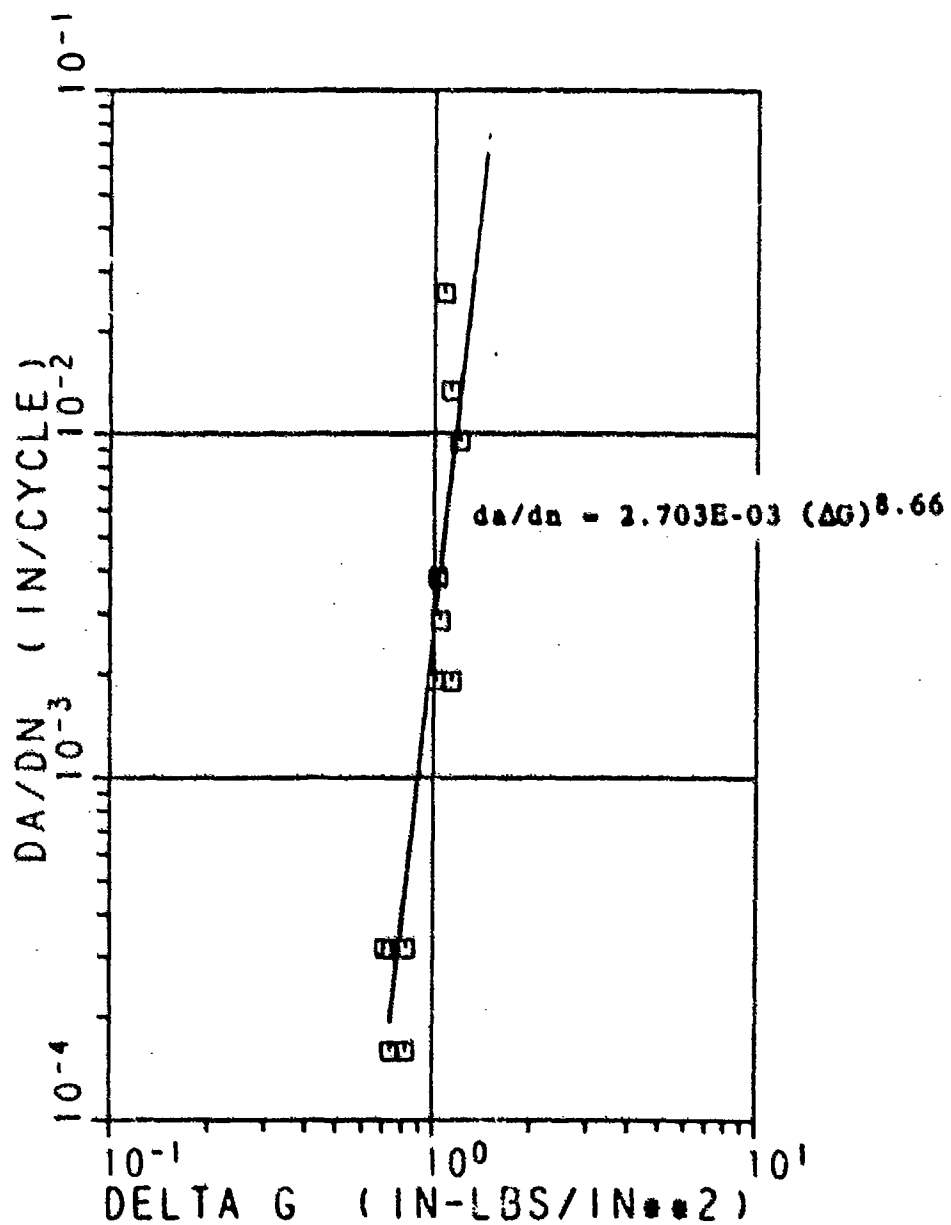


Figure A-22. IM6/F650 Mixed Mode (CLS-63) at ETW Conditions

MIXED MODE CRACK GROWTH DATA -- CLS-82  
IM6/F650 -- ETW ENVIRONMENT

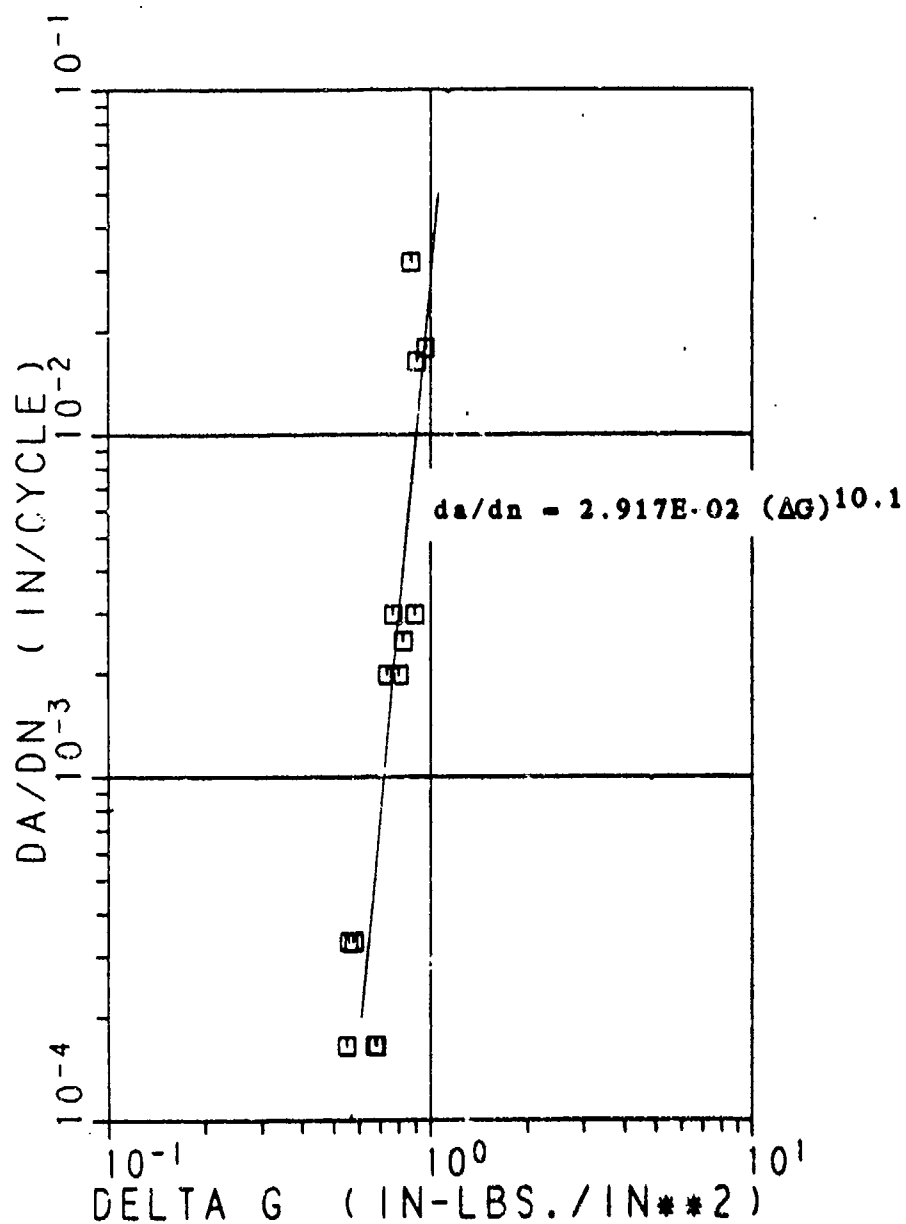


Figure A-23. IM6/F650 Mixed Mode (CLS-82) at ETW Conditions

MODE II CRACK GROWTH DATA  
IM6/F650 -- ETW ENVIRONMENT

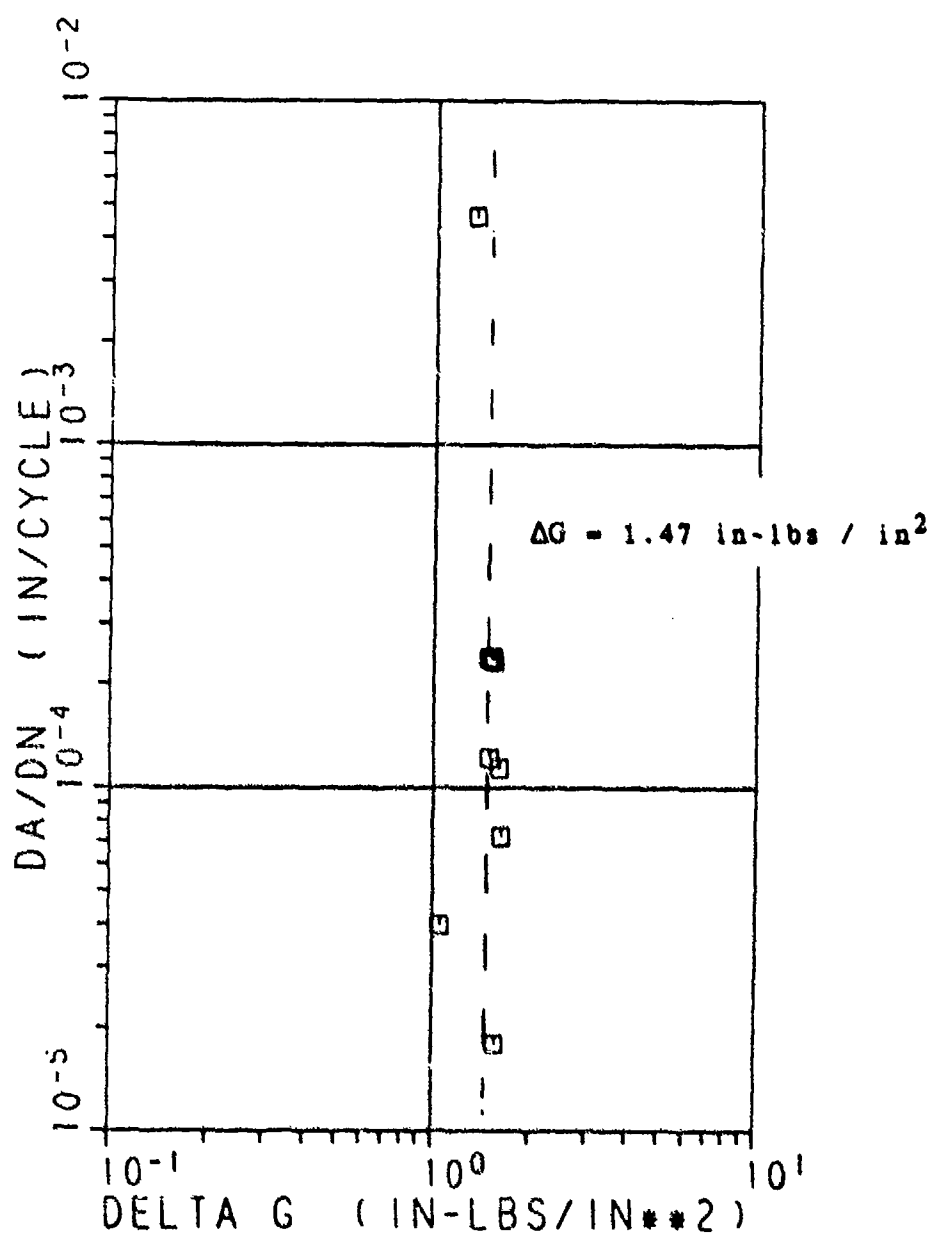


Figure A-24. IM6/F650 Mode II at ETW Conditions

## APPENDIX B

### IMPACT DAMAGE/RESIDUAL STRENGTH DATA

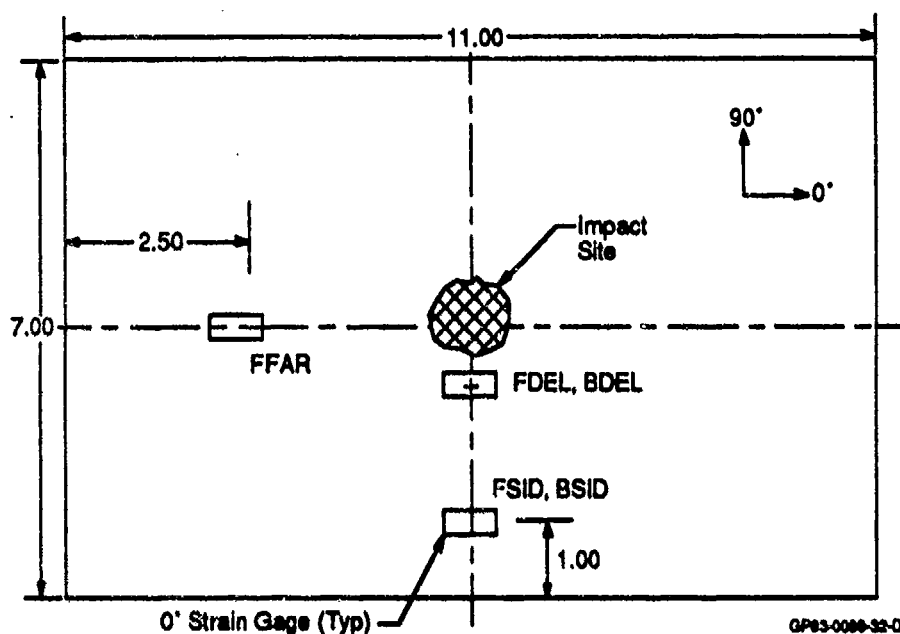
The low-velocity impact damage work performed on 11 inch by 7 inch panels is summarized in this appendix. The data is separated into the three groups: maximum non-visible damage, thin laminate damage, and visible damage. Each section includes a summary table listing data for one representative panel from each of the test conditions. Each table is followed by three types of data sheets for the RTD panels included in the table. The first type of data sheet shows plots of acceleration and back-surface strain as functions of time (during impact). In some cases, two impacts were done on a panel when the first impact failed to produce sufficient damage. For those panels, there are two sheets showing plots of acceleration and back-surface strain. The second type of sheet shows a C-scan of the impact damage. The third type of sheet shows a load vs. strain plot for five strain gages that monitored the residual compression behavior of each panel.

C-scans are not included for panels tested under ETW conditions for residual compression strength. Since these panels were impacted under RTD conditions, the C-scans would not be significantly different from the C-scans reported for analogous RTD panels.

The summary table includes three impact energy levels. Nominal impact energy is the level that was targeted for the panel. Potential impact energy is the energy based on the height and weight of the impactor. Kinetic impact energy is the energy based on the mass of the impactor and its velocity as measured by optical sensors just prior to striking the panel surface. The impact energies are followed by the maximum acceleration ( $G_{\max}$ ) and the maximum back-surface bending strain ( $\epsilon_{\max}$ ) that occurred during impact. Maximum load can be determined by multiplying impactor weight by  $G_{\max}$ . Dent depth and delamination width (from C-scans) describe the impact damage state. Finally residual strength and strain are listed.

The third data sheet for each panel shows a load-strain plot for the five locations shown in Figure B-1. The symbol labeled FFAR on the plot represents the front-face (impact side) far field strain response. The symbols

FSID and BSID represent the strain responses, 1 inch in from the side of the panel, on the front-face and back-face of the panel respectively. The symbols FDEL and BDEL represent the strain responses adjacent to the impact delamination on the front-face and back-face of the panel respectively.



GP83-0088-32-0

- Notes: (1) FFAR = Front, Far-Field Strain  
 (2) FDEL = Front, Delamination Edge Strain  
 (3) BDEL = Back, Delamination Edge Strain  
 (4) FSID = Front, Panel Side Strain  
 (5) BSID = Back, Panel Side Strain

Figure B-1. Definition of Panel Strain Gage Locations

**B.1 MAXIMUM NON-VISIBLE IMPACT DAMAGE**

Material	Specimen Number	Layup	Thickness (in.)	Impact Weight (lb)	Nominal Impact Energy (ft-lb)	Potential Impact Energy (ft-lb)	Kinetic Impact Energy (ft-lb)	G <sub>max</sub>	C <sub>max</sub> (µin./in.)	Dent Depth (in.)	Delamination Width (in.)	Residual Strength (ksi)	Residual Strain (µin./in.)
RTD													
IM6/3100	1-12-2	10/80/10	0.114	3.83	8	8.52	8.32	315	11,880	0.005	1.1	32.1	6,200
	1-11-2		0.221	3.83	14	14.91	14.21	706	14,740	0.009	2.1	26.8	5,400
	1-13-1		0.451	7.82	17.5/23	18.6/24.4	18.1/—	949	9,630	0.008	3.9	29.2	6,150
IM6/3100	1-14-2	50/40/10	0.110	3.83	14	14.91	14.44	421	7,150	0.006	1.5	38.5	3,200
	1-20-2		0.224	7.82	23	24.44	23.58	555	14,530	0.011	3.4	30.8	2,600
	1-15-2		0.453	19.47	42	44.62	—	546	11,720	0.012	3.7	36.2	3,450
IM6/F650	2-12-2	10/80/10	0.106	3.83	6	6.38	6.26	268	8,440	0.007	1.4	21.4	3,800
	2-11-3		0.216	3.83	7	7.44	7.32	633	11,730	0.010	1.8	21.2	4,250
	2-13-1		0.436	7.82	20	21.24	20.47	707	9,690	0.012	3.6	22.5	4,500
IM6/F650	2-14-1	50/40/10	0.111	3.83	14	7.44	—	256	14,820	0.007	1.7	32.0	2,700
	2-20-2		0.219	7.82	10	10.62	10.35	305	4,400	0.012	2.0	28.1	2,500
	2-15-2		0.443	19.47	35	37.32	—	756	9,340	0.017	3.0	26.5	2,500
ETW													
IM6/3100	1-12-4	10/80/10	0.114	3.83	8	8.52	—	335	15,070	0.005	—	22.9	3,900
	1-11-5		0.222	3.83	14	14.91	14.13	874	15,740	0.009	—	21.2	5,000
	1-13-4		0.449	7.82	23	24.44	23.43	1,078	10,580	0.006	—	24.8	5,150
IM6/3100	1-14-4	50/40/10	0.110	3.83	14	14.91	14.34	462	18,160	0.005	—	32.6	2,050
	1-20-4		0.225	7.82	23	24.44	23.43	520	14,540	0.008	—	25.4	2,650
	1-15-4		0.451	7.82	17.5/23	24.44	—	963	9,110	0.010	—	28.5	2,600
IM6/F650	2-12-5	10/80/10	0.106	3.83	6	6.38	—	257	10,830	0.007	—	17.5	3,100
	2-11-6		0.216	3.83	7	7.44	7.28	649	9,650	0.011	—	17.5	3,500
	2-13-5		0.436	7.82	15	15.97	15.56	790	7,570	0.010	—	17.1	2,550
IM6/F650	2-14-5	50/40/10	0.111	3.83	14	7.44	7.32	299	13,160	0.006	—	23.5	1,800
	2-20-4		0.219	7.83	10	10.62	10.31	375	5,910	0.012	—	21.6	1,550
	2-15-4		0.441	7.82	35	43.08	35.61	927	9,710	0.016	—	18.9	1,500

GP83-0088-2-T

Figure B-2. Maximum Non-Visible Impact Damage Data Table

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

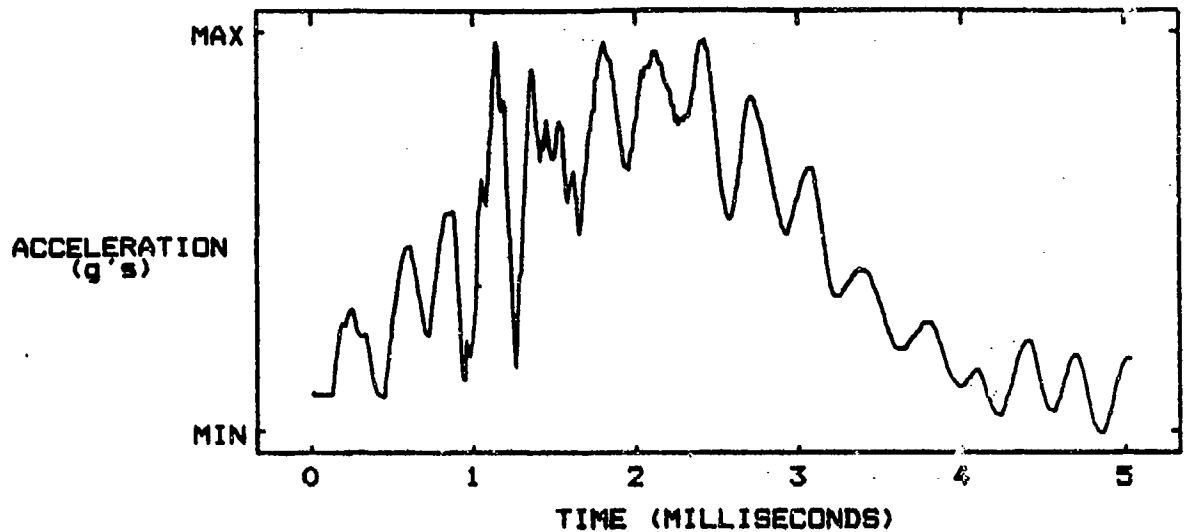
SPECIMEN I.D. 1-12-2

THICKNESS .114 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 26.7 IN

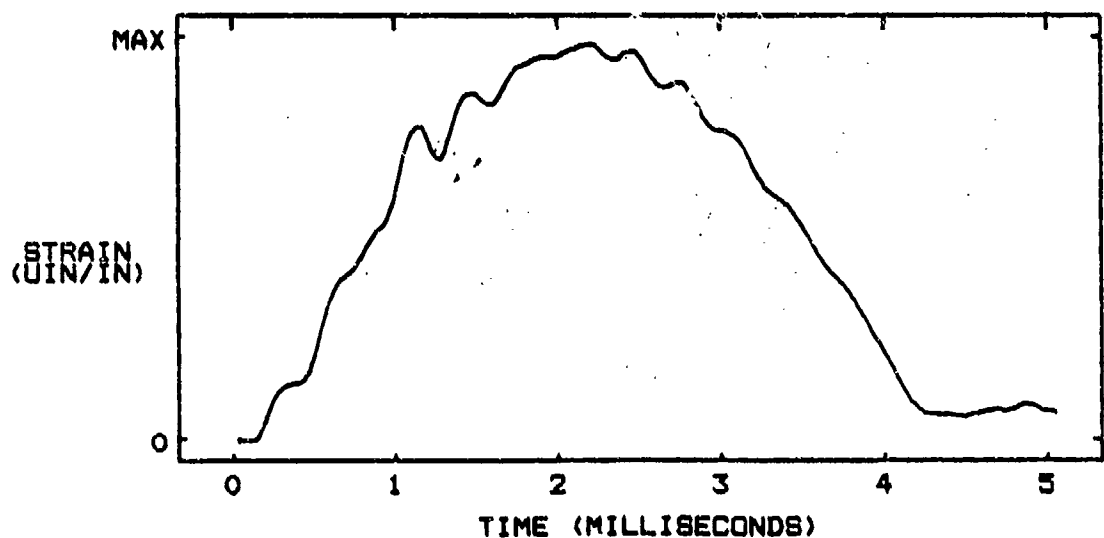
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -33.2 g's      MAXIMUM ACCELERATION 315.43 g's

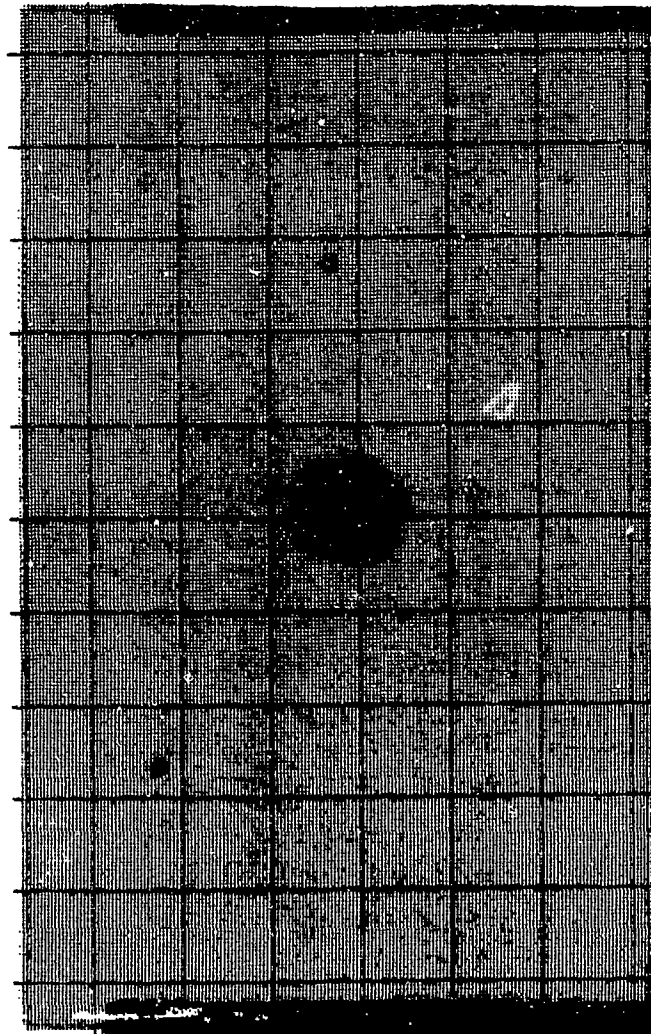
INTEGRATED TOTAL VELOCITY 230.19 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 11882 UIN/IN

Figure B-3. Panel 1-12-2 Impact Response Data



**Specimen 1-12-2**

**Figure B-4. Panel 1-12-2 C-Scan**

# CSAI - IM6/3100

PANEL 1-12-2 (RTD)

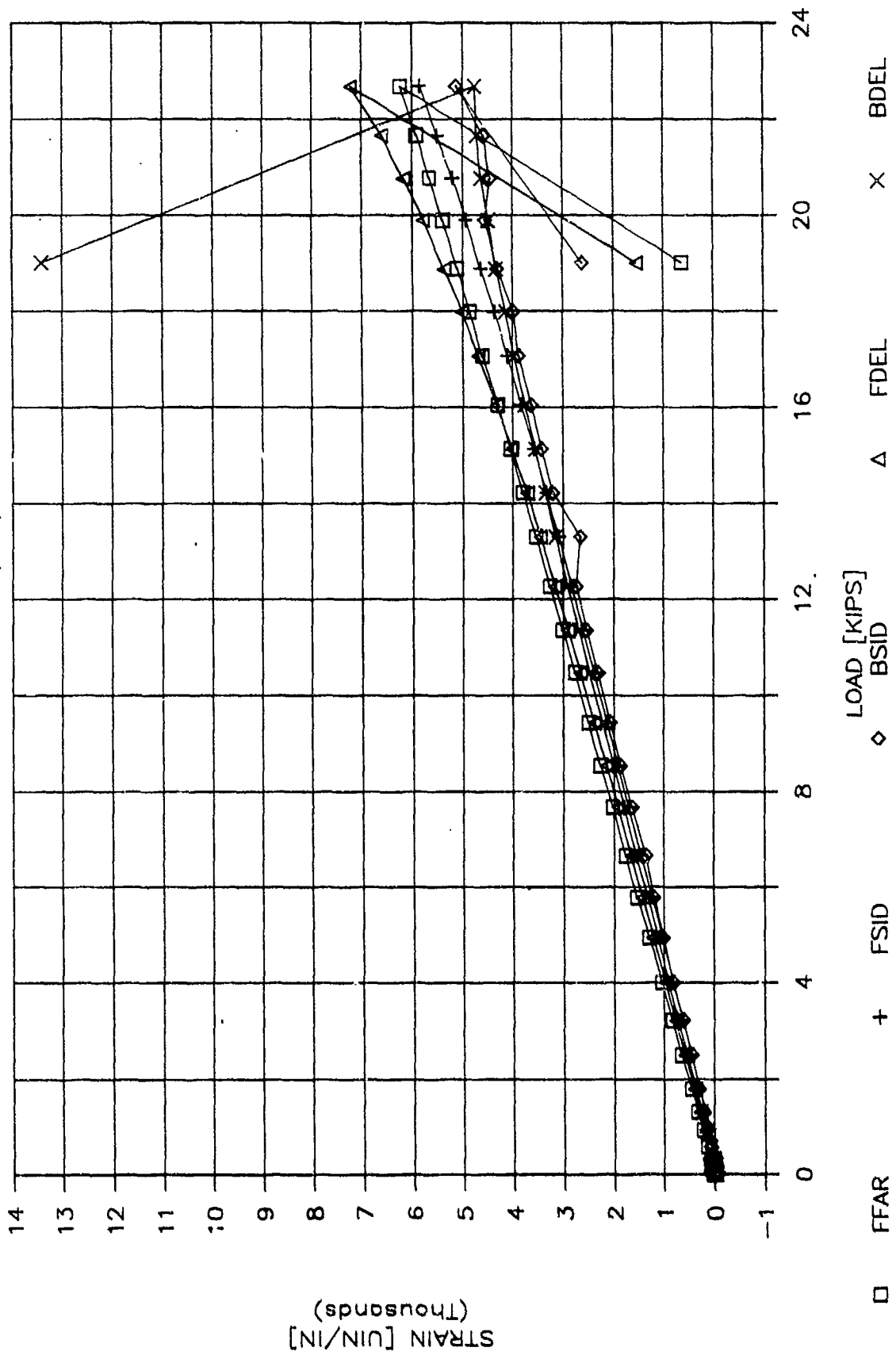


Figure B-5. Panel 1-12-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

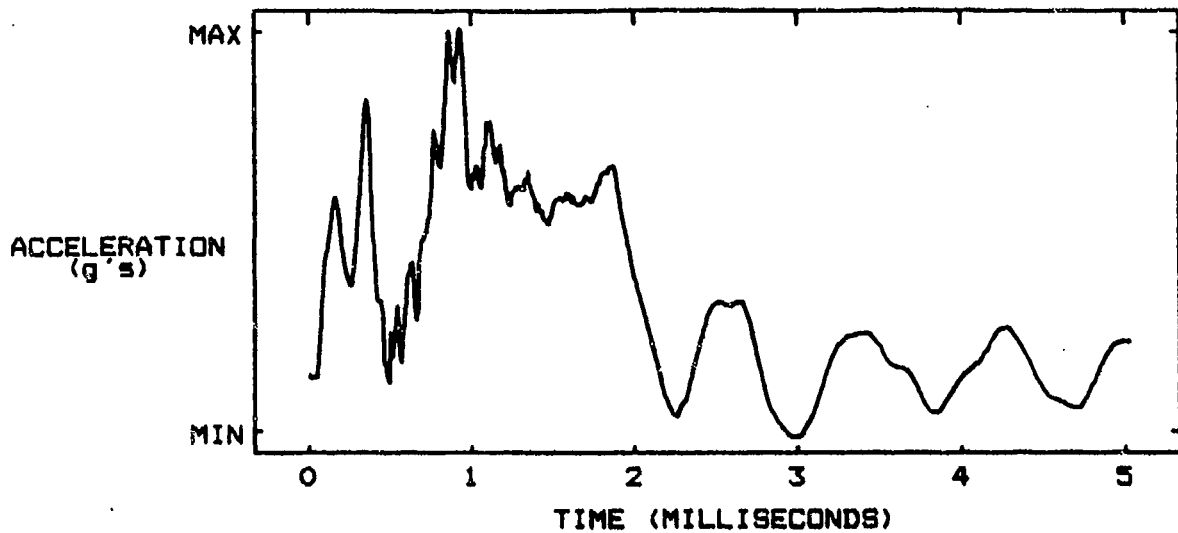
SPECIMEN I.D. 1-11-2

THICKNESS .221 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 46.7 IN

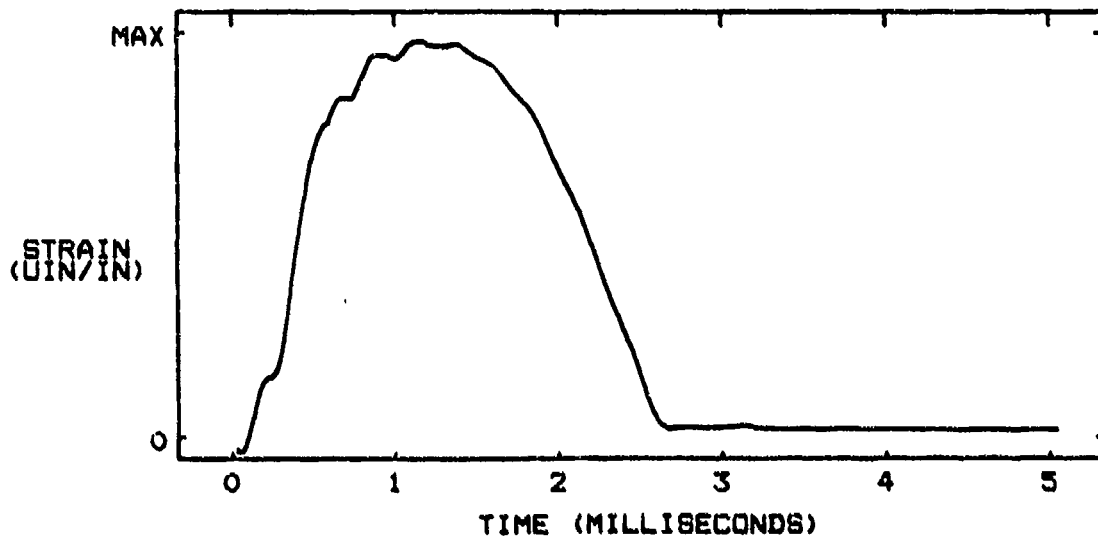
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -126 g's      MAXIMUM ACCELERATION 706.0 g's

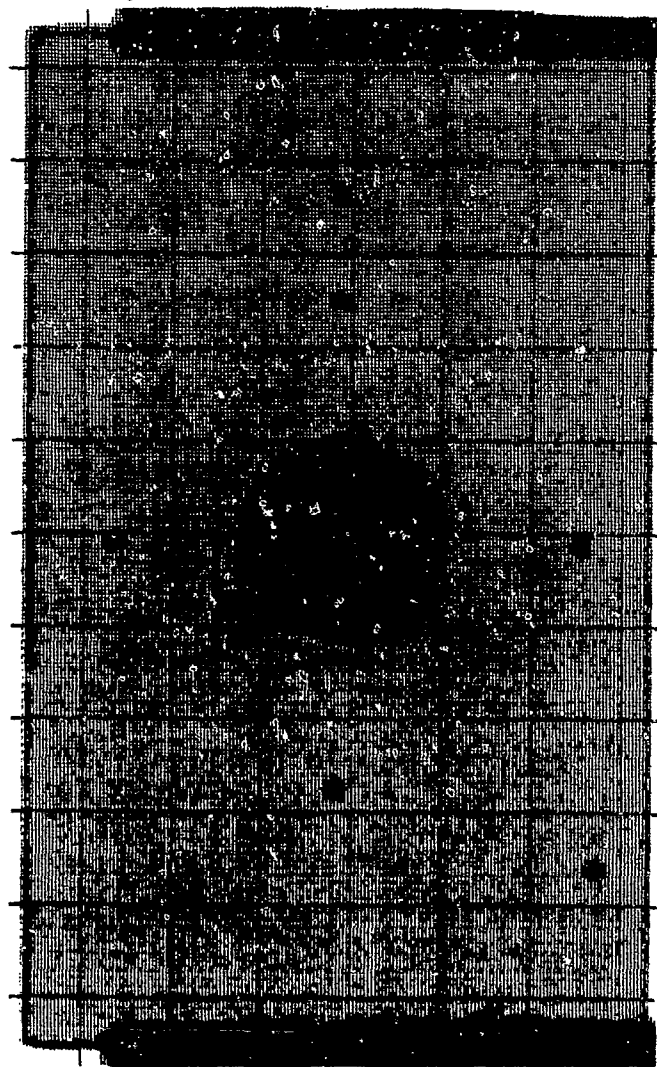
INTEGRATED TOTAL VELOCITY 271.88 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14740 UIN/IN

Figure B-6. Panel 1-11-2 Impact Response Data



Specimen 1-11-2

Figure B-7. Panel 1-11-2 C-Scan

# CSAI - IM6/3100

PANEL 1-11-2 (RTD)

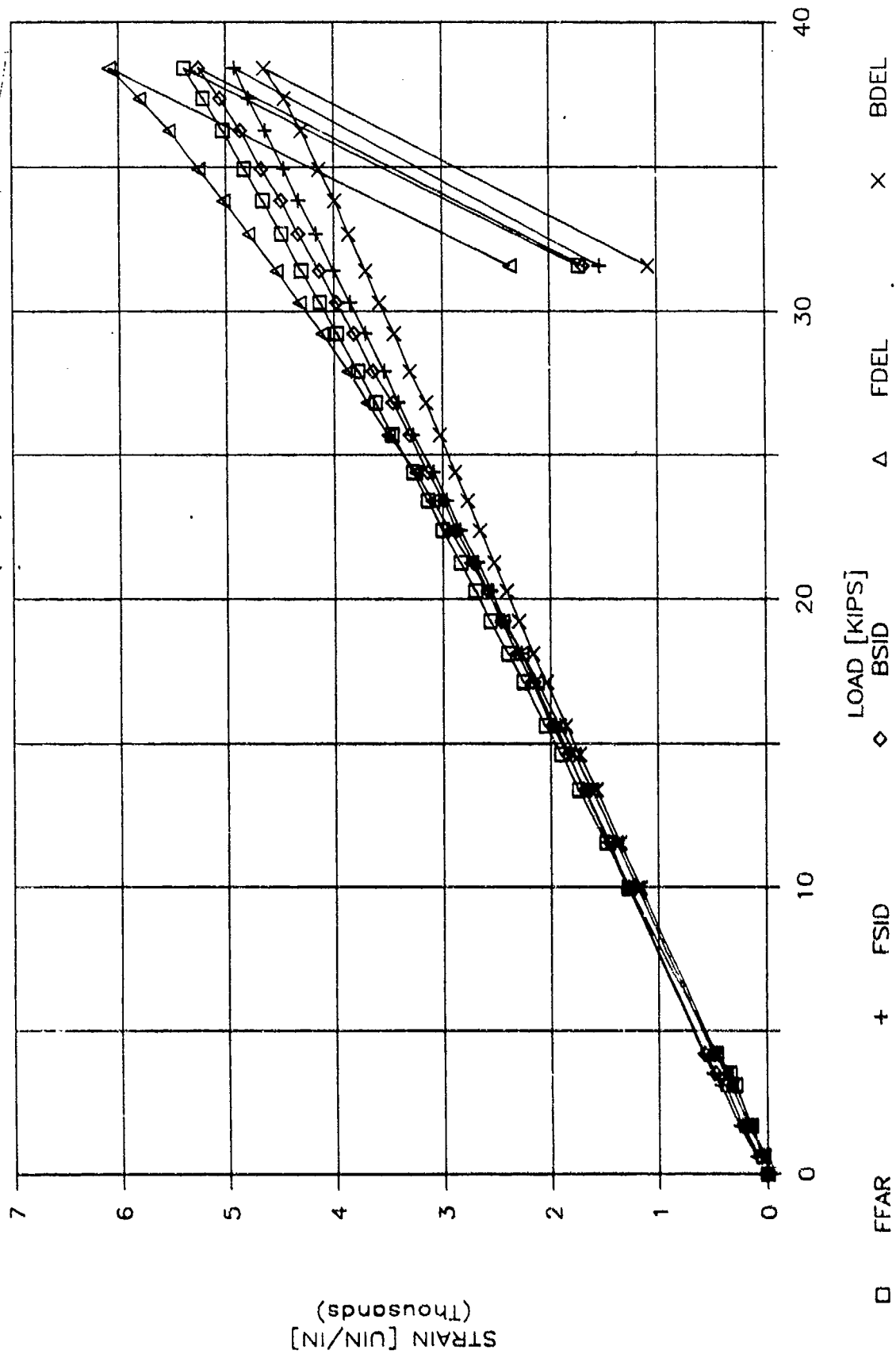


Figure B-8. Panel 1-11-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

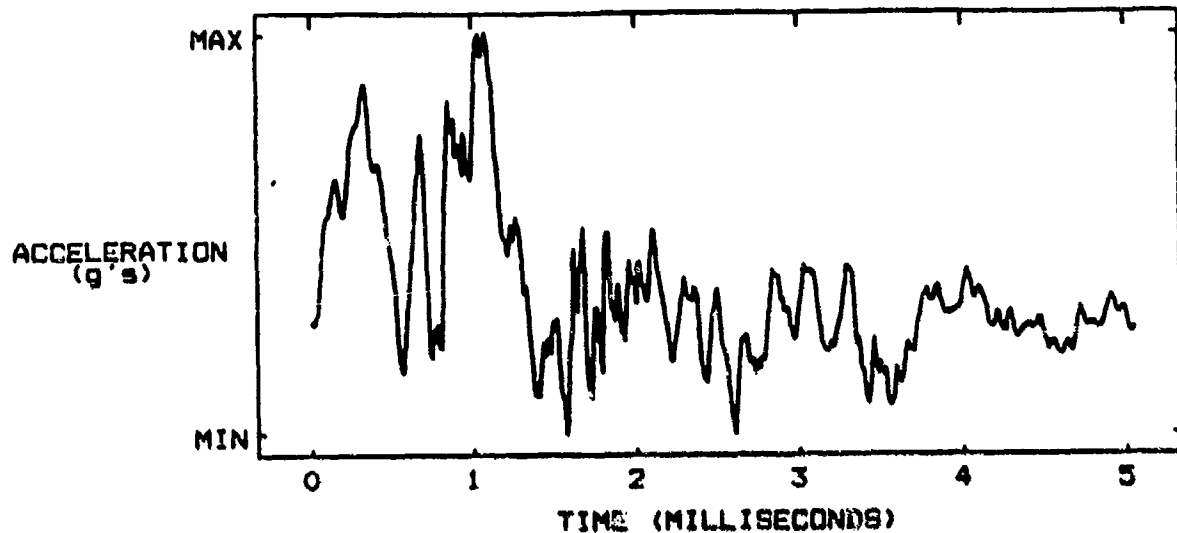
SPECIMEN I.D. 1-13-1.1

THICKNESS .451 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 28.5 IN

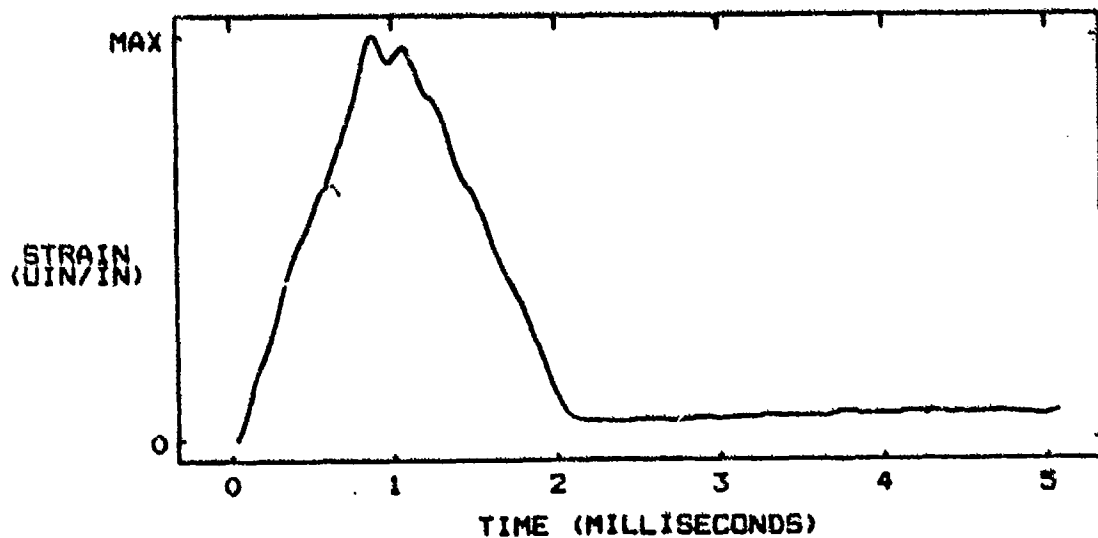
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -363 g's      MAXIMUM ACCELERATION 949.22 g's

INTEGRATED TOTAL VELOCITY 188.26 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9632.8 UIN/IN

Figure B-9. Panel 1-13-1 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

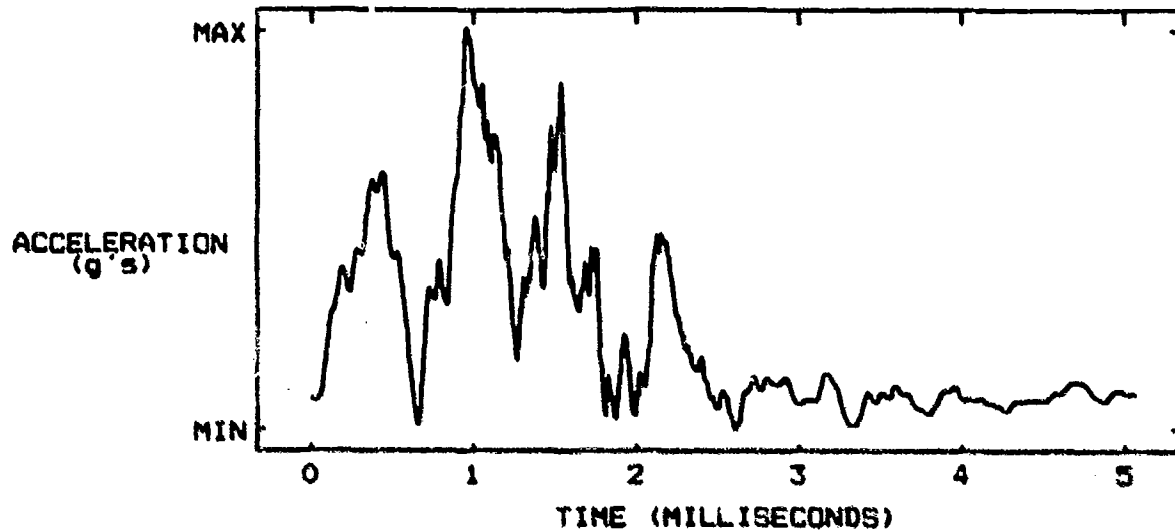
SPECIMEN I.D. 1-13-1.2

THICKNESS .451 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 37.5 IN

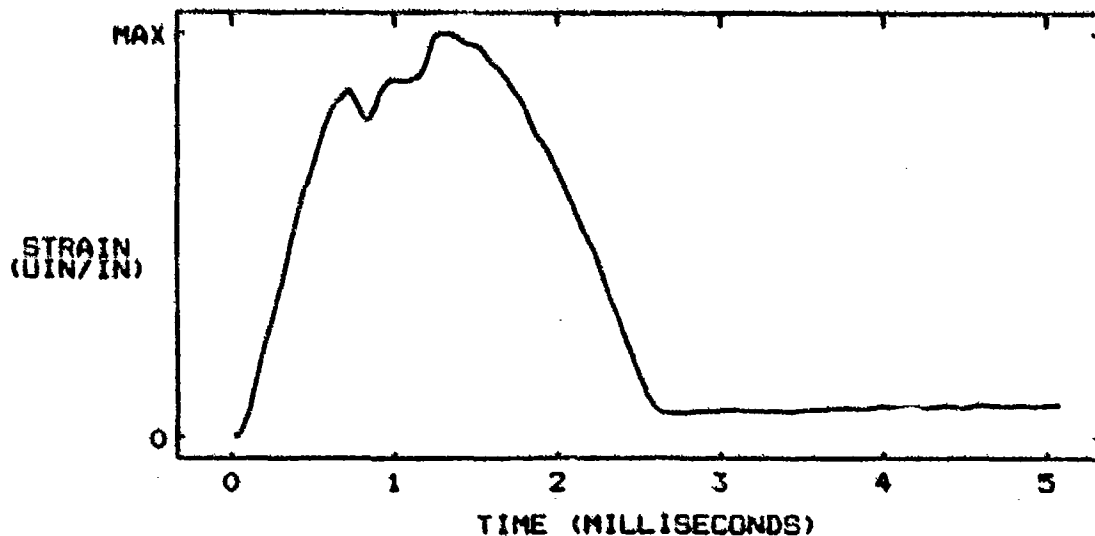
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -60.5 g's      MAXIMUM ACCELERATION 837.89 g's

INTEGRATED TOTAL VELOCITY 260.22 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 12294 UIN/IN

Figure B-10. Panel 1-13-1 Second Impact Response Data



Specimen 1-13-1

Figure B-11. Panel 1-13-1 C-Scan

# CSAI - IM6/3100

PANEL 1-13-1 (RTD)

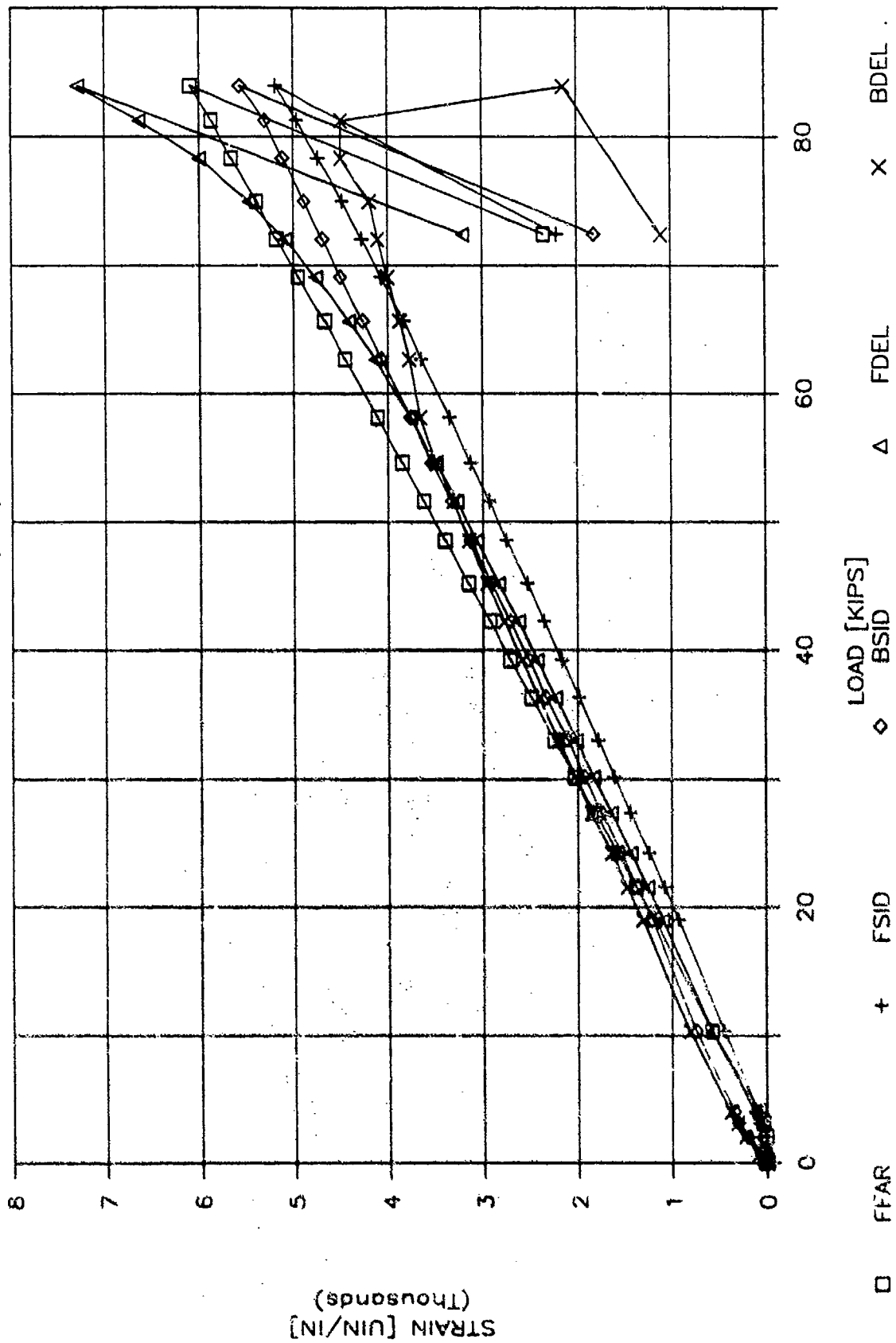


Figure B-12. Panel 1-13-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

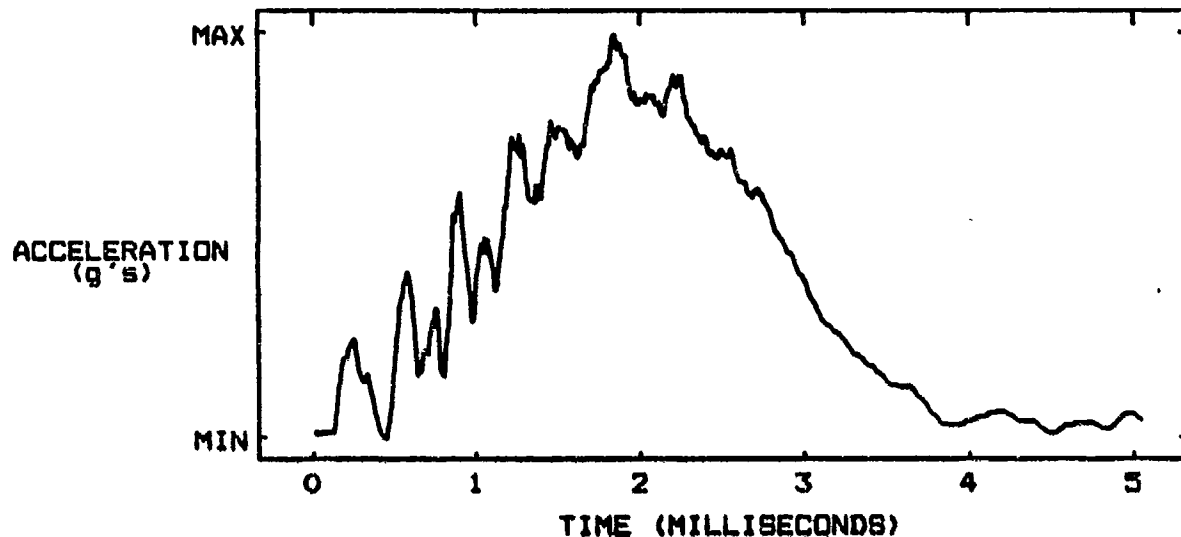
SPECIMEN I.D. 1-14-2

THICKNESS .110 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 46.7 IN

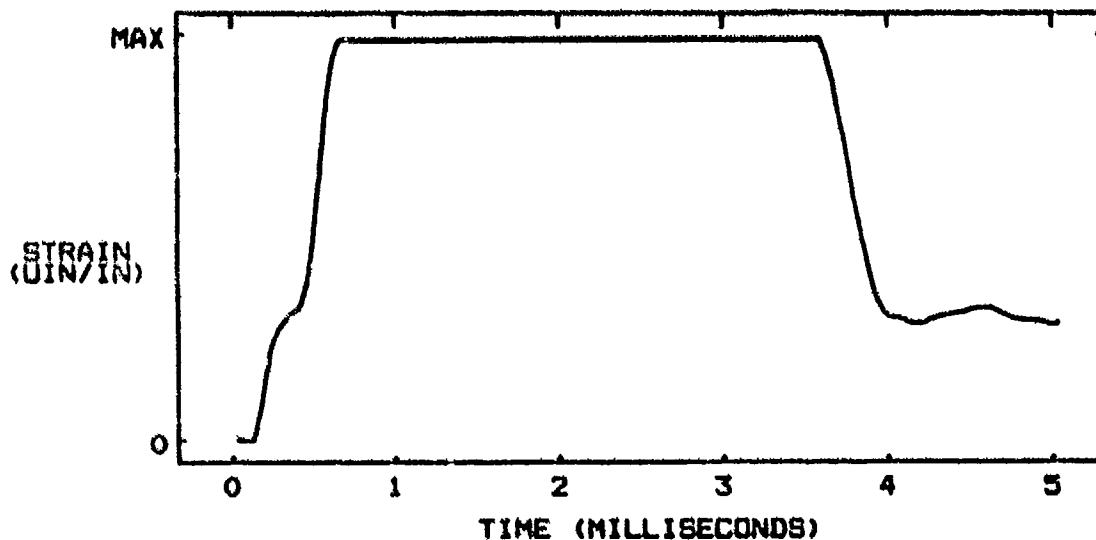
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -6 g's      MAXIMUM ACCELERATION 421 g's

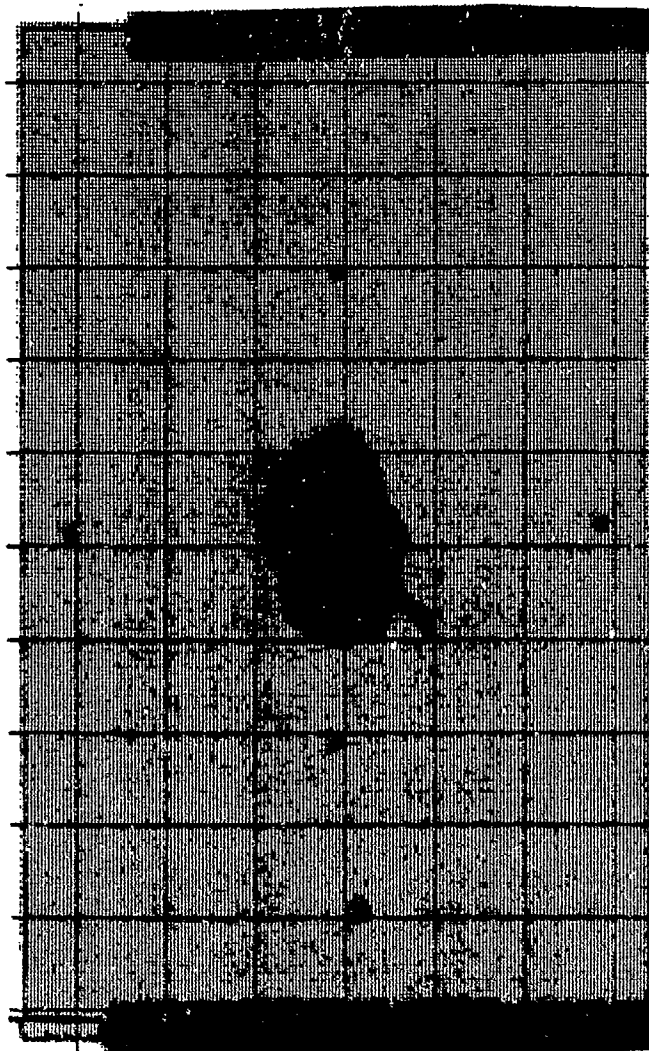
INTEGRATED TOTAL VELOCITY 291.3 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 7148 UIN/IN

Figure B-13. Panel 1-14-2 Impact Response Data



Specimen 1-14-2

Figure B-14. Panel 1-14-2 C-Scan

# CSAI - IM6/3100

PANEL 1-14-2 (RTD)

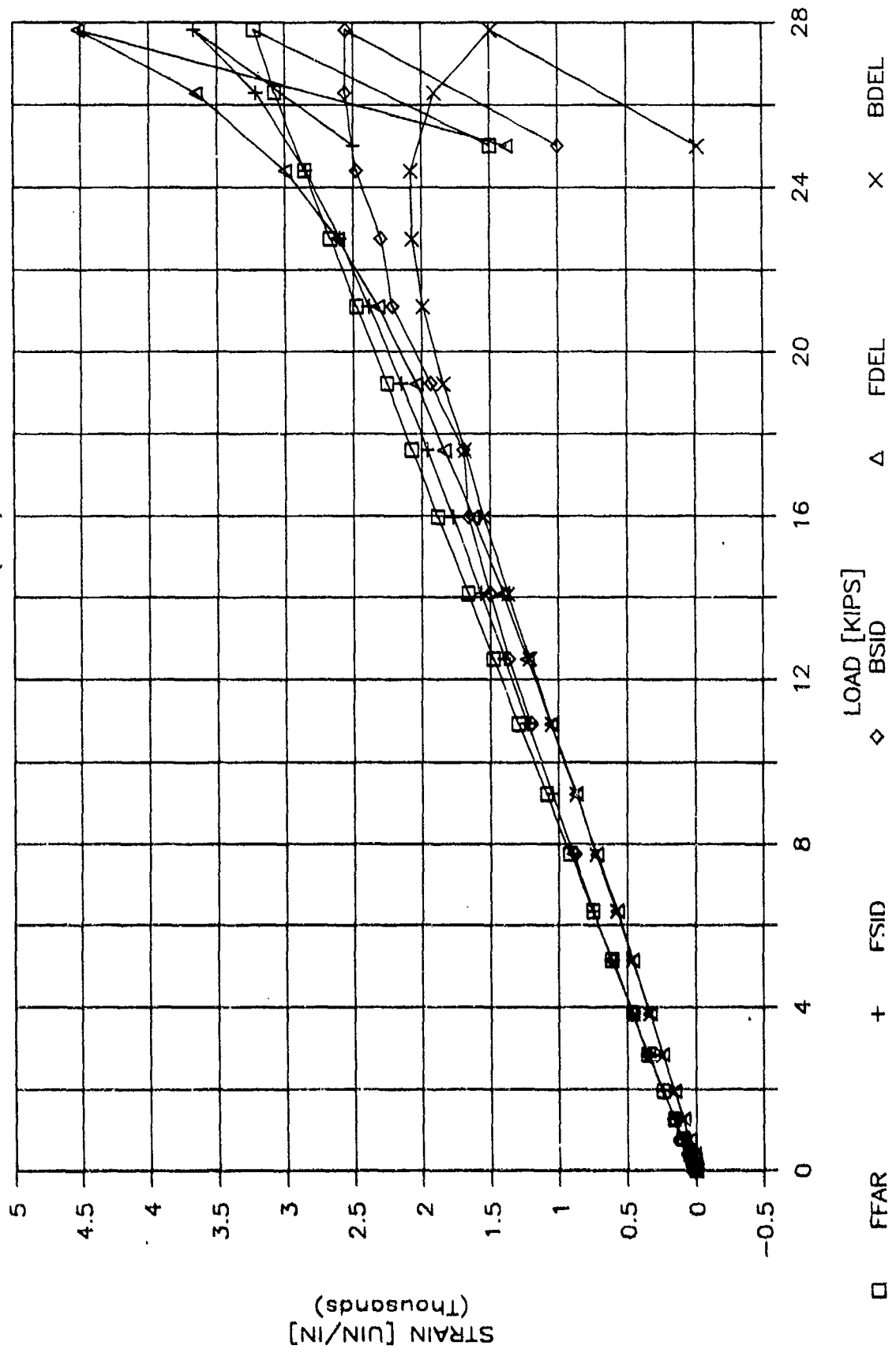


Figure B-15. Panel 1-14-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

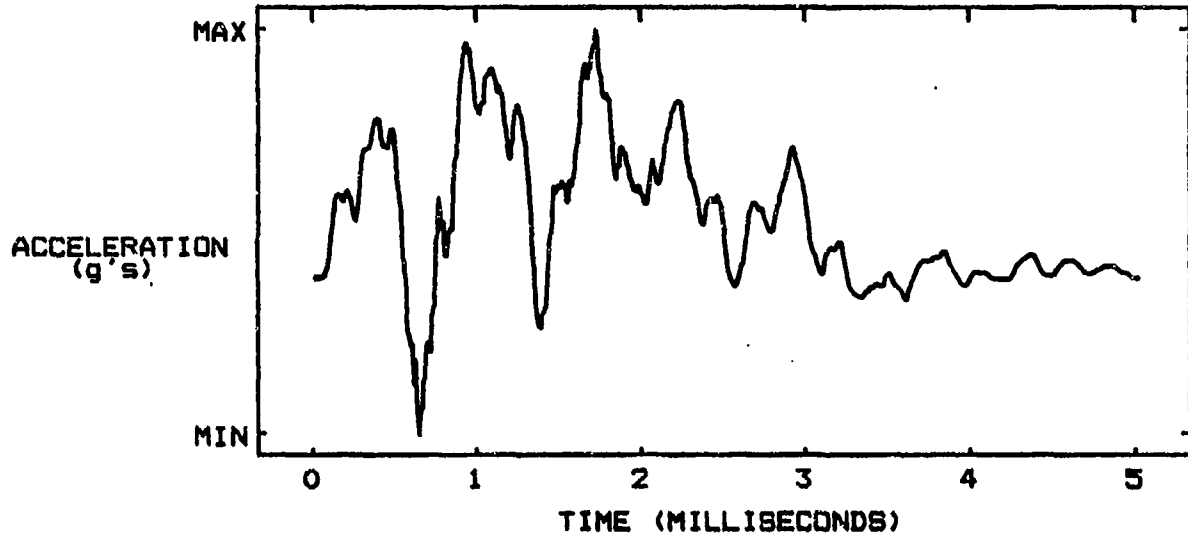
SPECIMEN I.D. 1-20-2

THICKNESS .224 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 37.5 IN

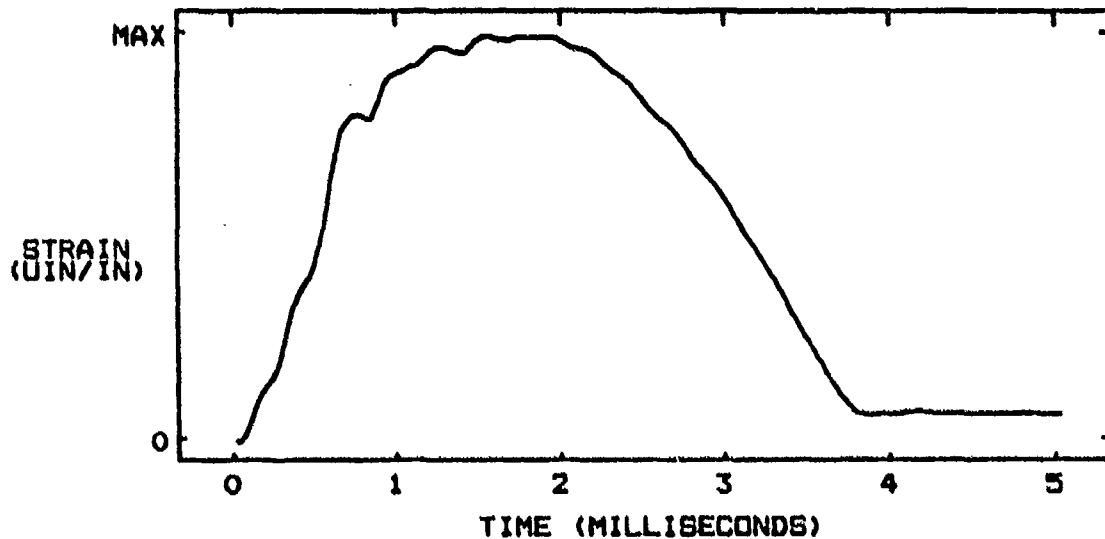
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -353 g's      MAXIMUM ACCELERATION 554.7 g's

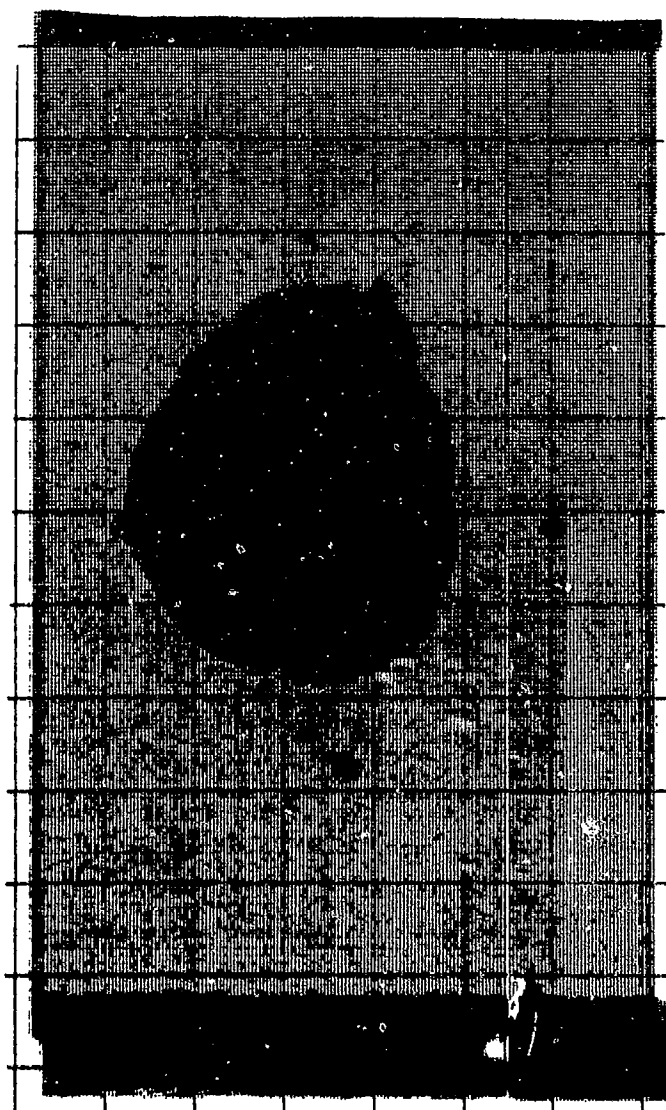
INTEGRATED TOTAL VELOCITY 248.57 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14534 UIN/IN

Figure B-16. Panel 1-20-2 Impact Response Data



**Specimen 1-20-2**

**Figure B-17. Panel 1-20-2 C-Scan**

# CSAI - IM6/3100

PANEL 1-20-2 (RTD)

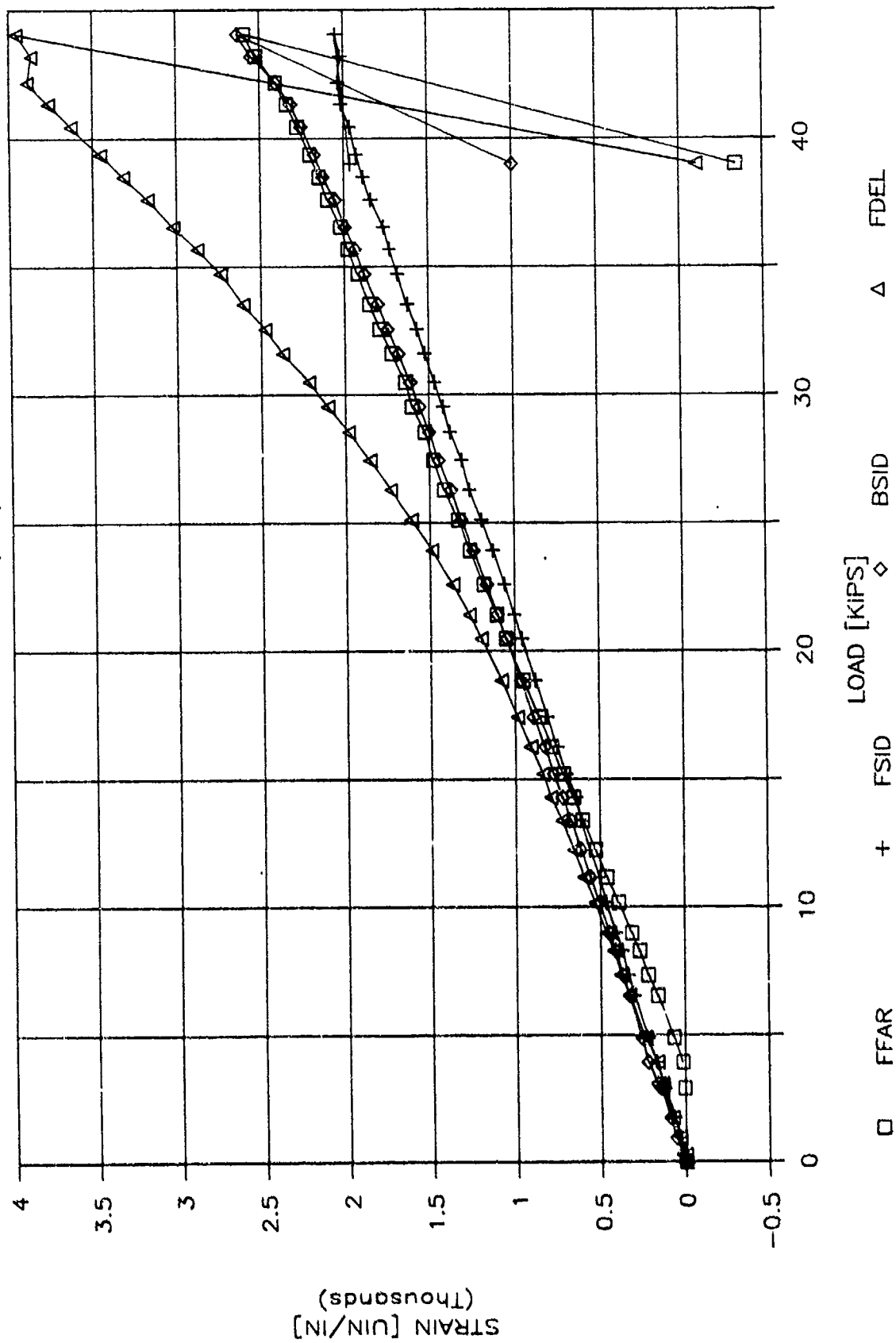


Figure B-18. Panel 1-20-2 Residual Compression Data

# LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

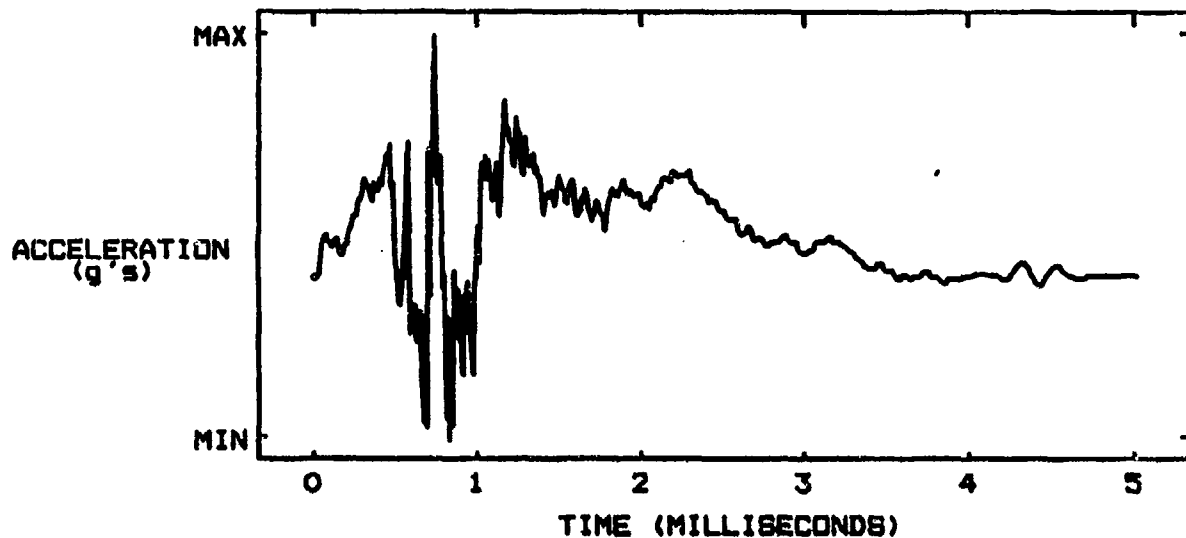
SPECIMEN I.D. 1-15-2

THICKNESS .453 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 27.5 IN

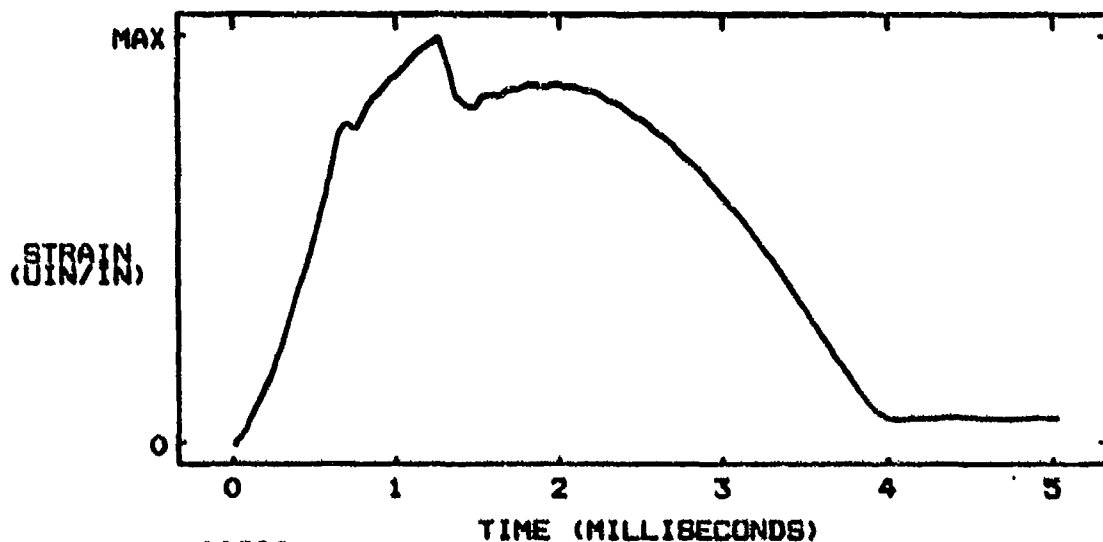
## ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -332 g's      MAXIMUM ACCELERATION 546 g's

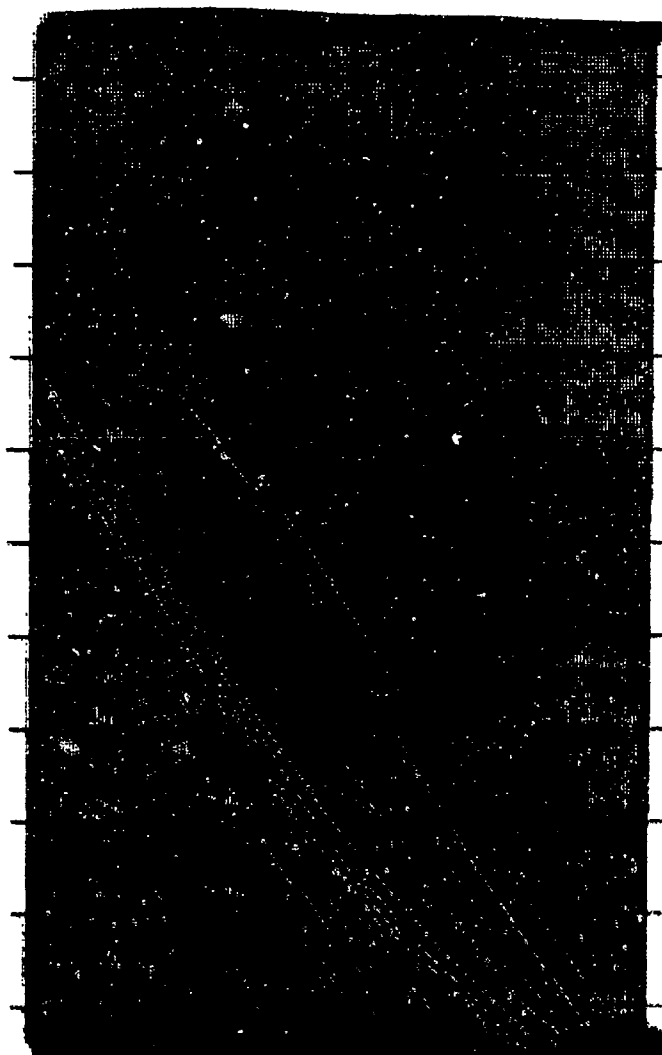
INTEGRATED TOTAL VELOCITY 166.56 IN/SEC

## PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 11732 UIN/IN

Figure B-10. Panel 1-15-2 Impact Response Data



Specimen 1-15-1

Figure B-20. Panel 1-15-1 C-Scan

# CSAI - IM6/3100

PANEL 1-15-2 (RTD)

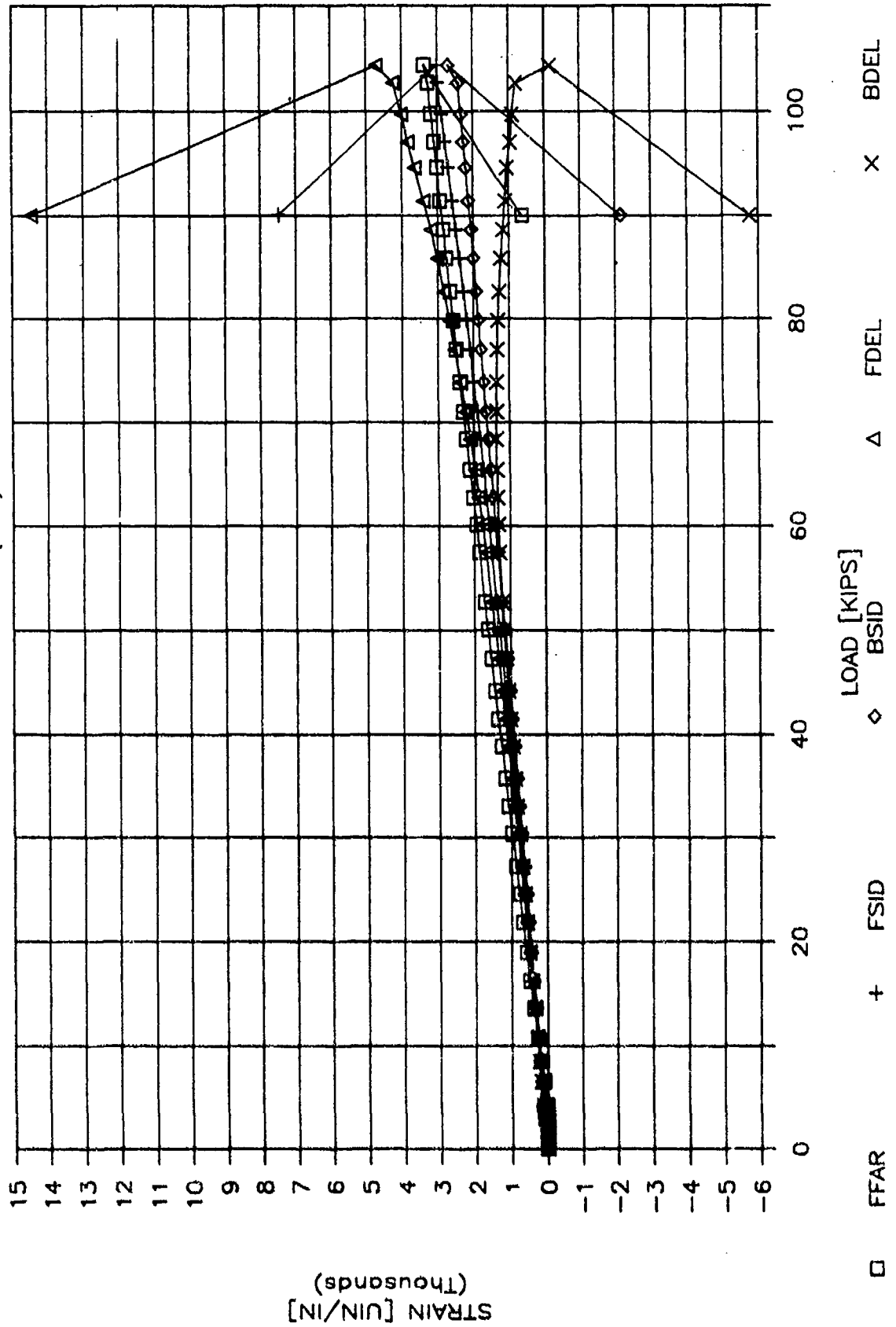


Figure B-21. Panel 1-15-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

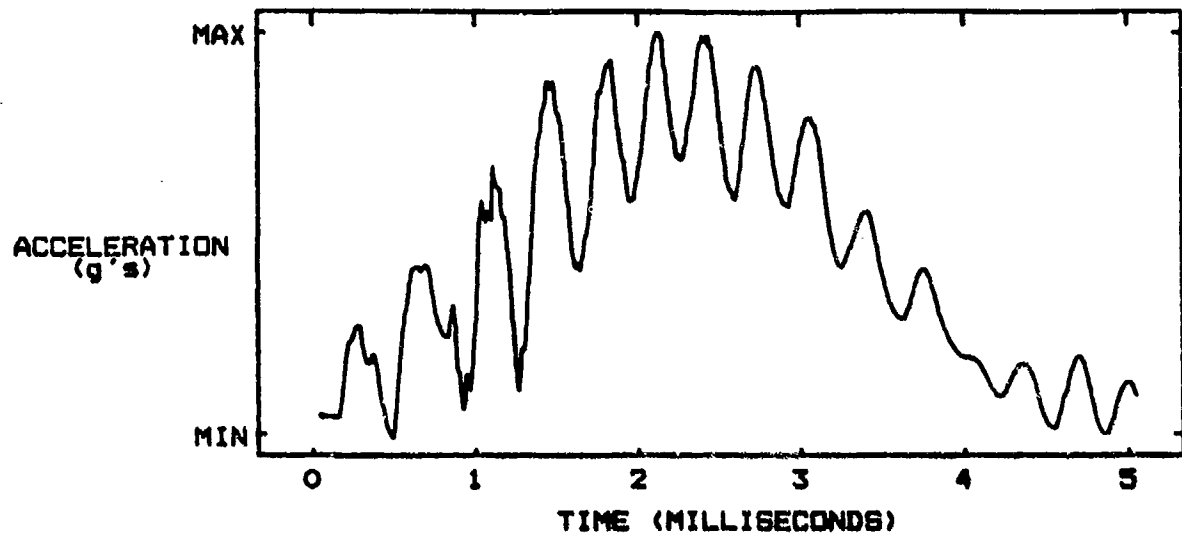
SPECIMEN I.D. 2-12-2

THICKNESS .106 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 20.0 IN

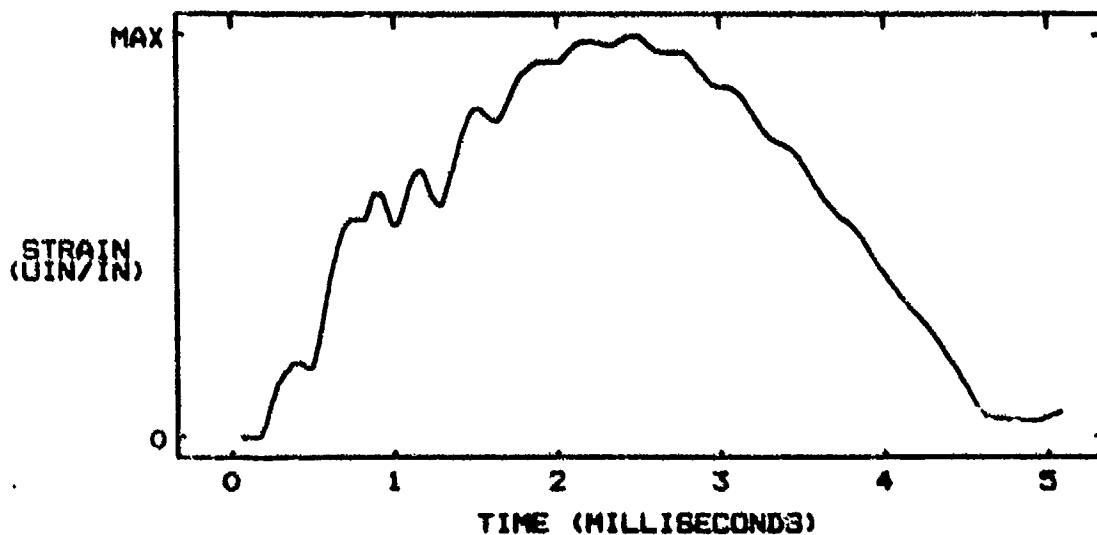
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -136.4 g's      MAXIMUM ACCELERATION 267.589 g's

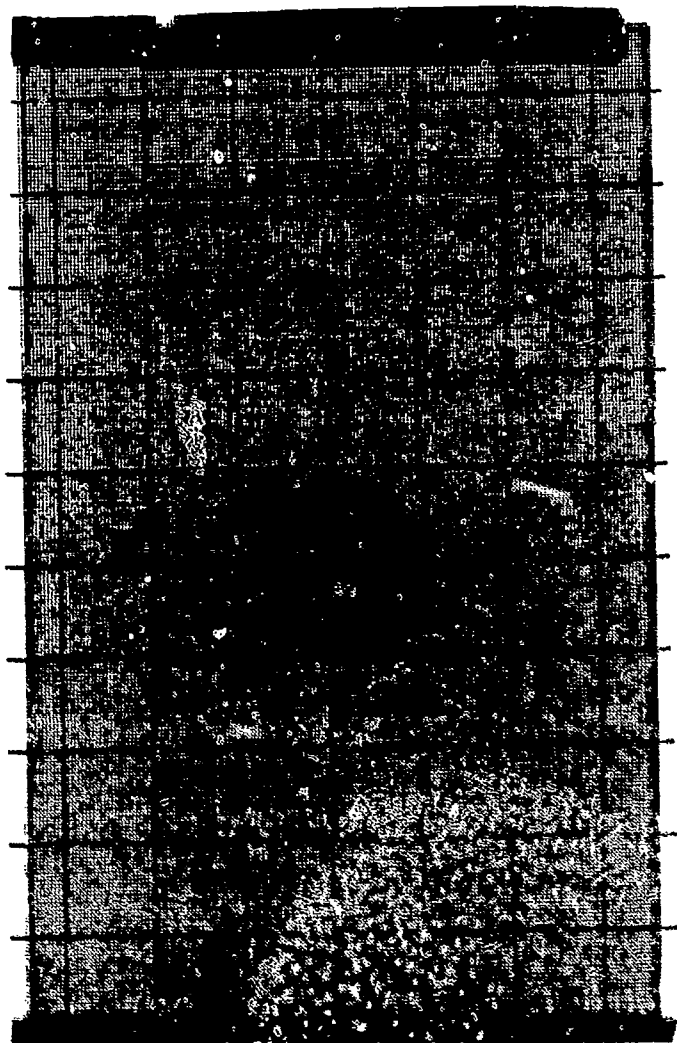
INTEGRATED TOTAL VELOCITY 202.55 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 8442.8 UIN/IN

Figure B-22. Panel 2-12-2 Impact Response Data



Specimen 3-12-2

Figure B-23. Panel 2-12-2 C-Scan

# CSA1 - IM6/F650

PANEL 2-12-2 (RTD)

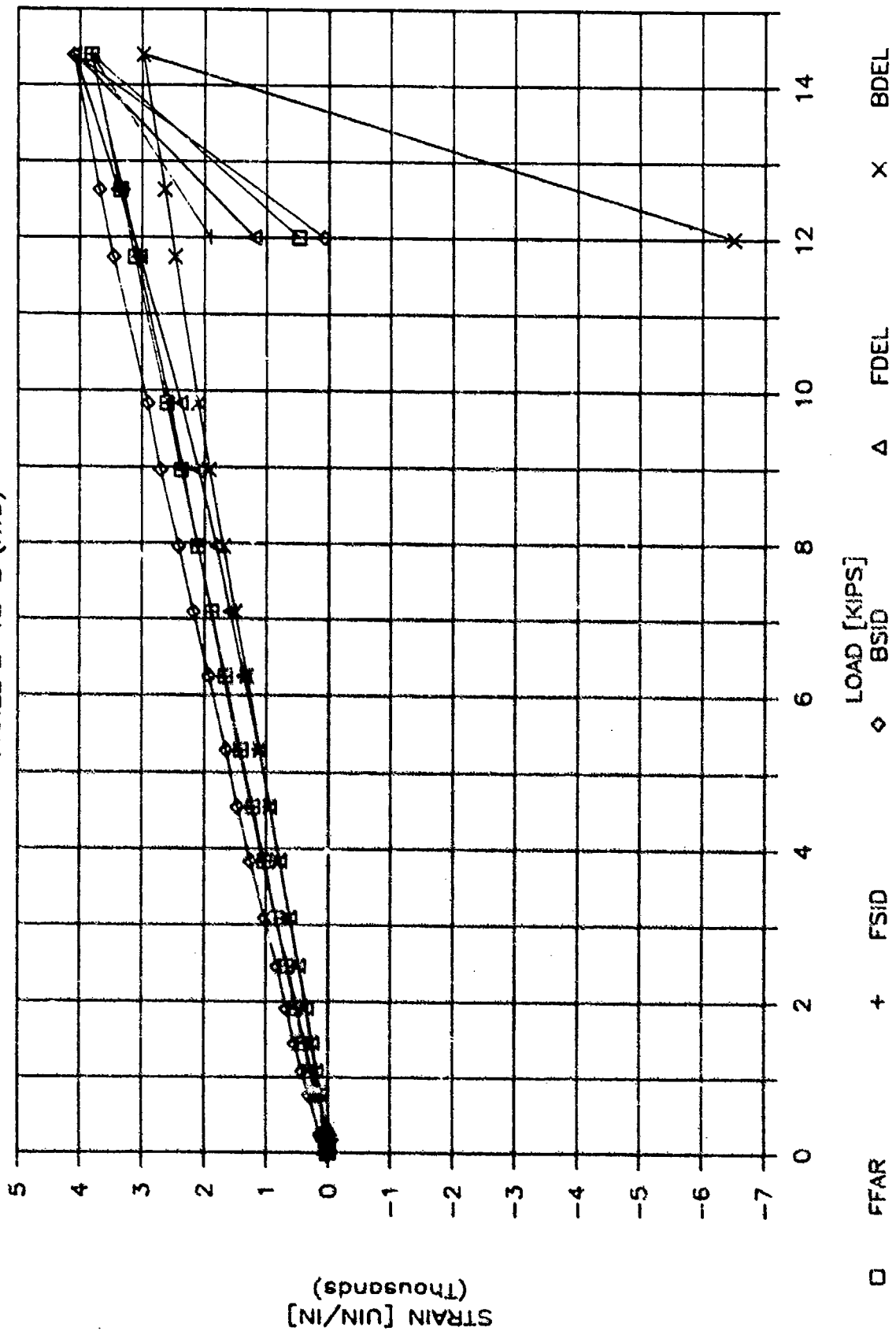


Figure B-24. Panel 2-12-2 Redual Compression Data

# LVID SPECIMEN DATA

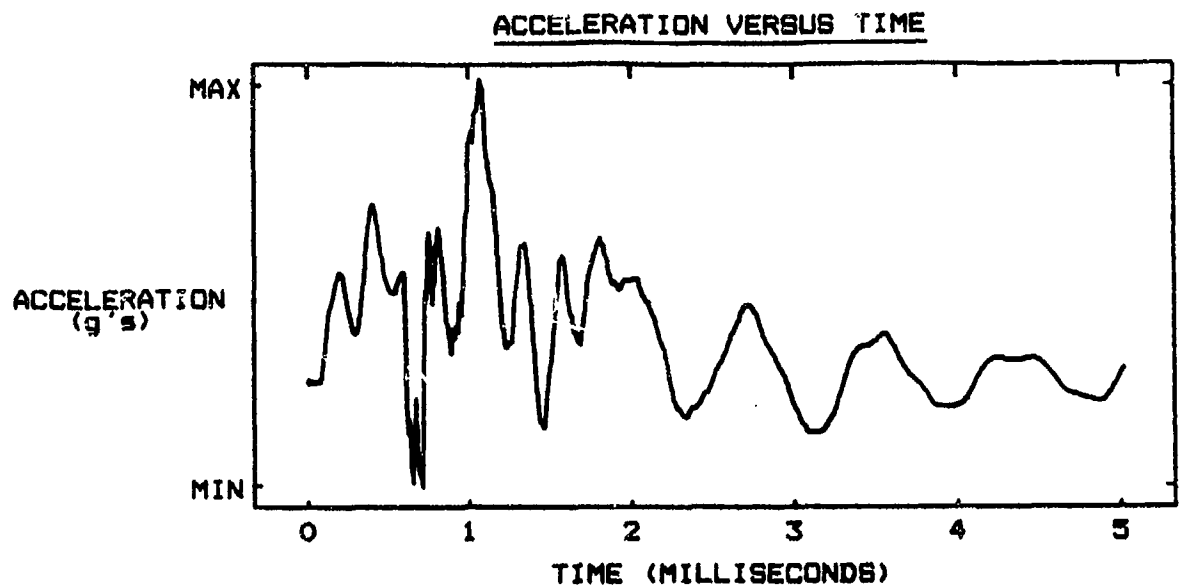
MATERIAL SYSTEM IM6/F650

SPECIMEN I.D. 2-11-3

THICKNESS .216 IN

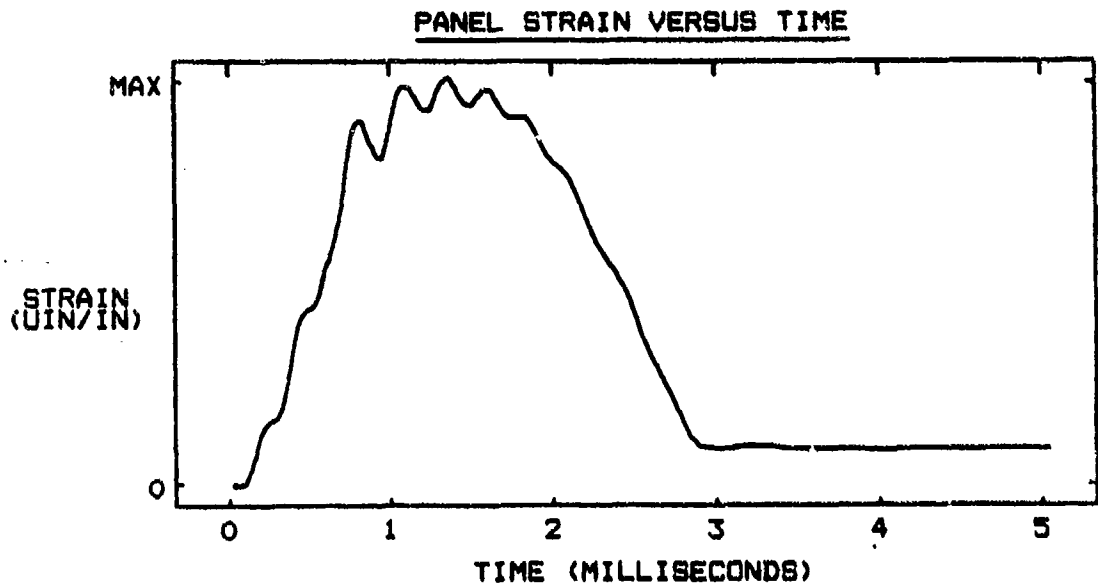
DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 23.3 IN



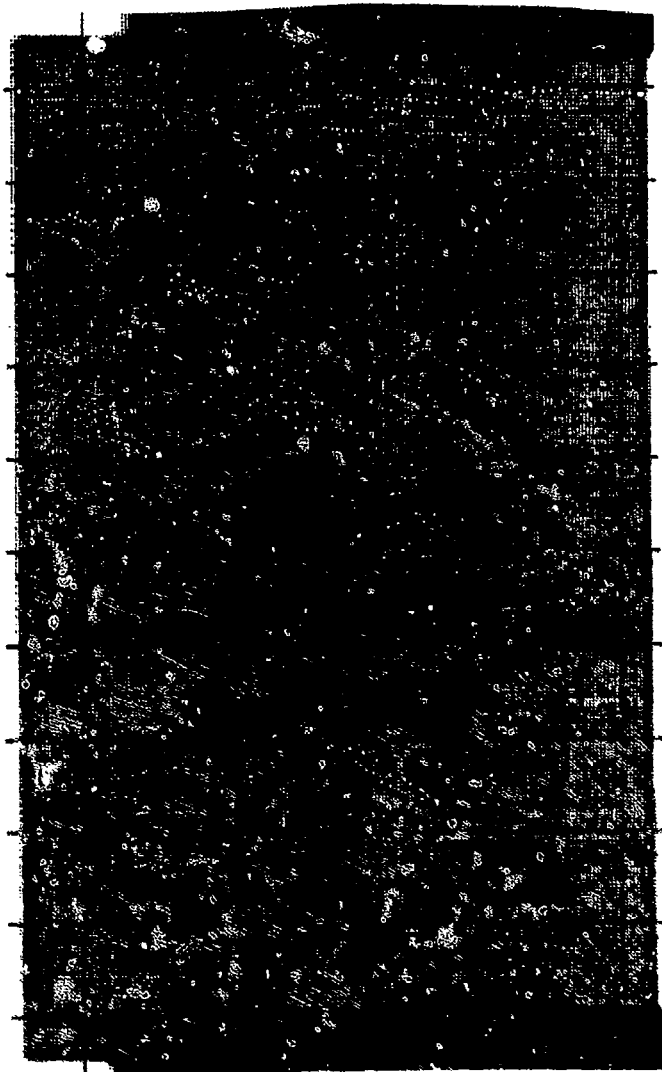
MINIMUM ACCELERATION -246 g's      MAXIMUM ACCELERATION 632.81 g's

INTEGRATED TOTAL VELOCITY 165.79 IN/SEC



MAXIMUM STRAIN 11732 UIN/IN

Figure B-25. Panel 2-11-3 Impact Response Data

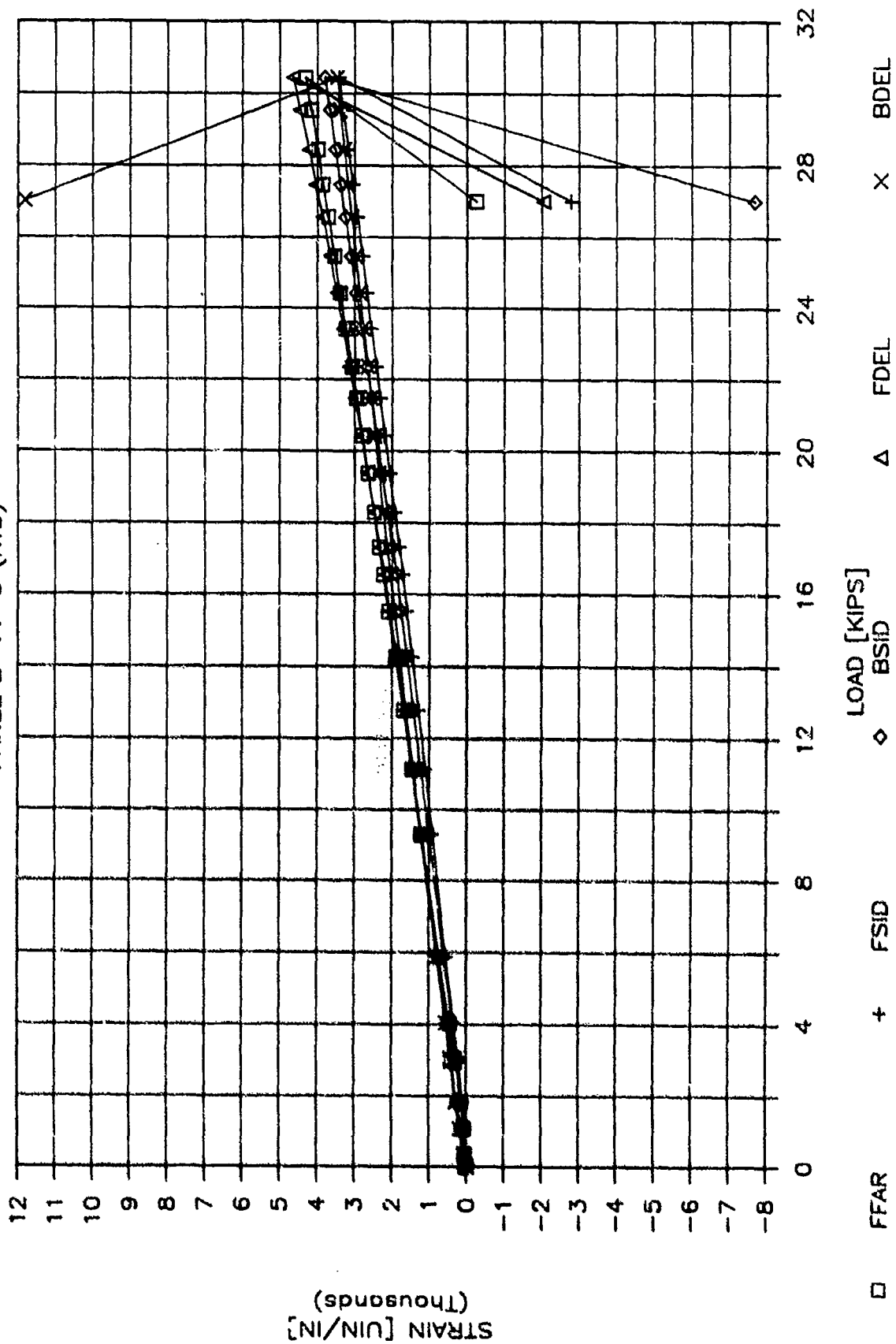


**Specimen 2-11-3**

**Figure B-26. Panel 2-11-3 C-Scan**

# CSAI - IM6/F650

PANEL 2-11-3 (RTD)



## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

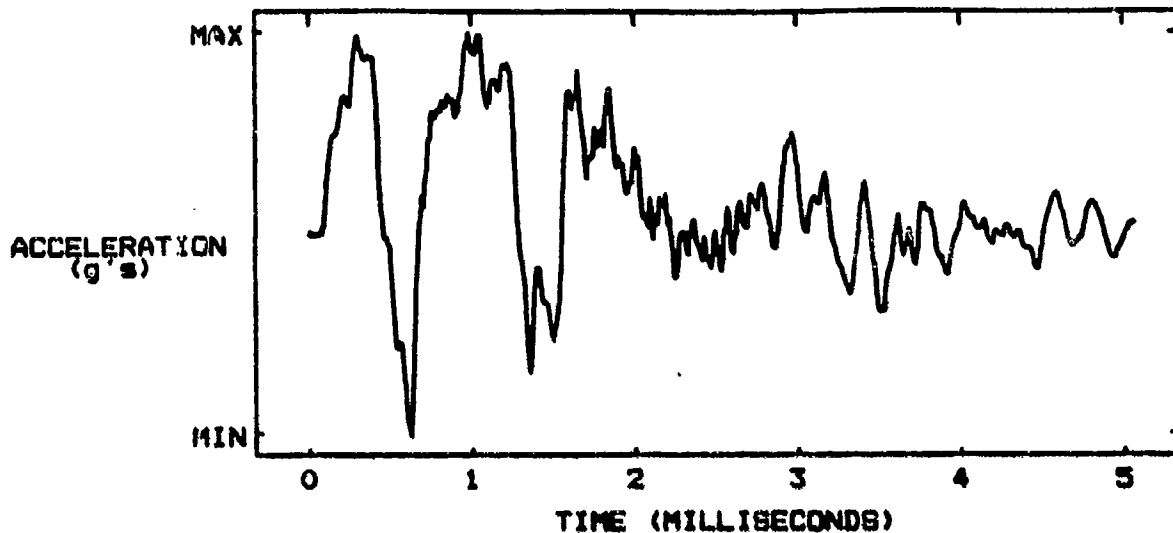
SPECIMEN I.D. 2-13-1

THICKNESS .436 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 32.6 IN

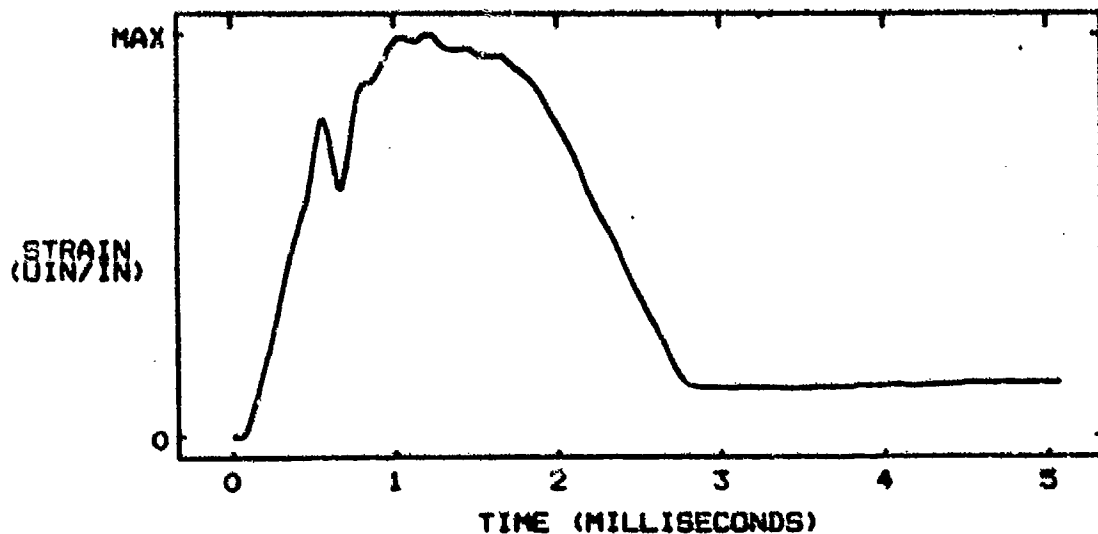
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -775 g's      MAXIMUM ACCELERATION 707 g's

INTEGRATED TOTAL VELOCITY 208.11 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9689 UIN/IN

Figure B-28. Panel 2-13-1 Impact Response Data



**Specimen 2-13-1**

**Figure B-29. Panel 2-13-1 C-Scan**

# CSAI - IM6/F650

PANEL 2-13-1 (RTD)

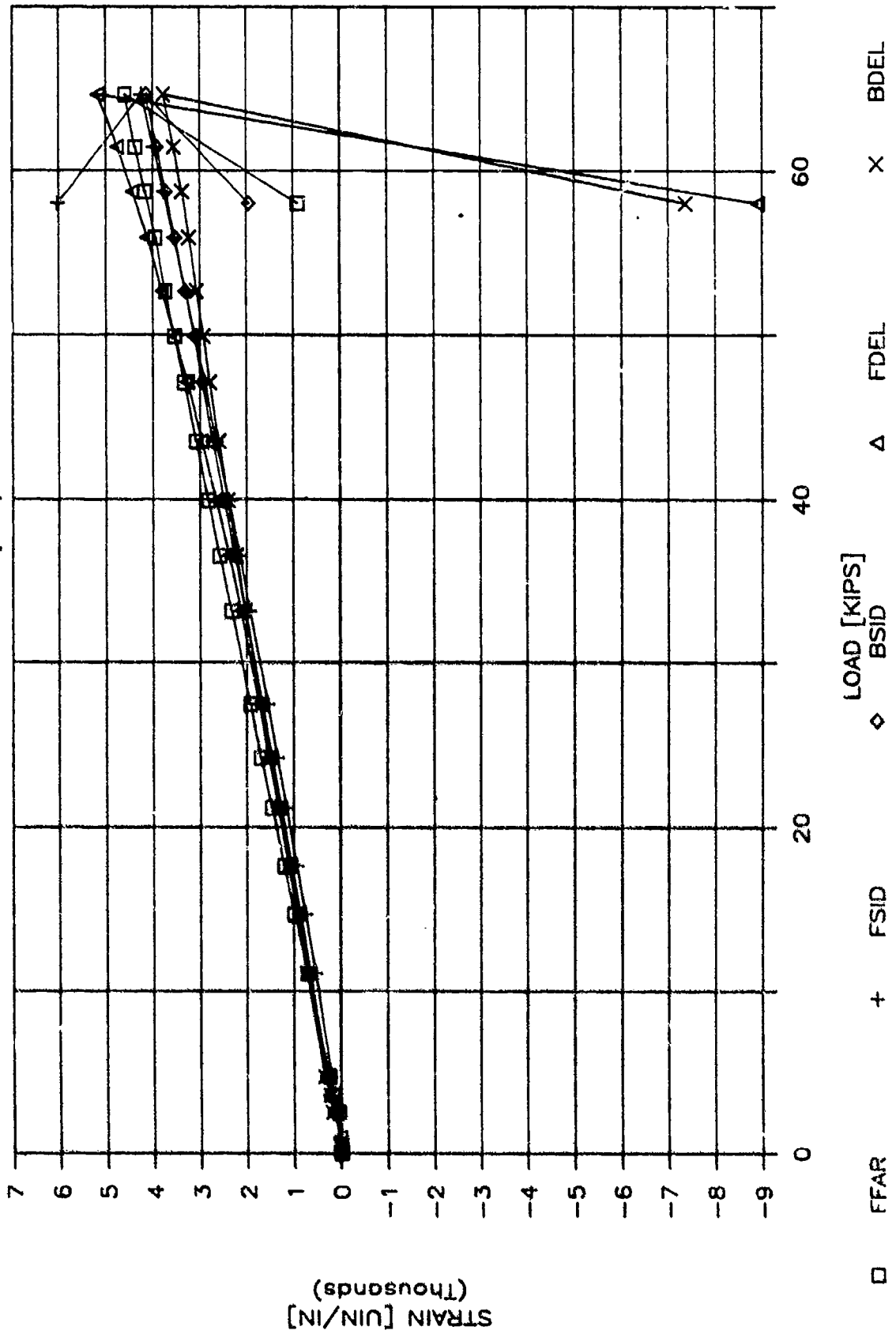


Figure B-30. Panel 2-13-1 Residual Compression Data

# LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

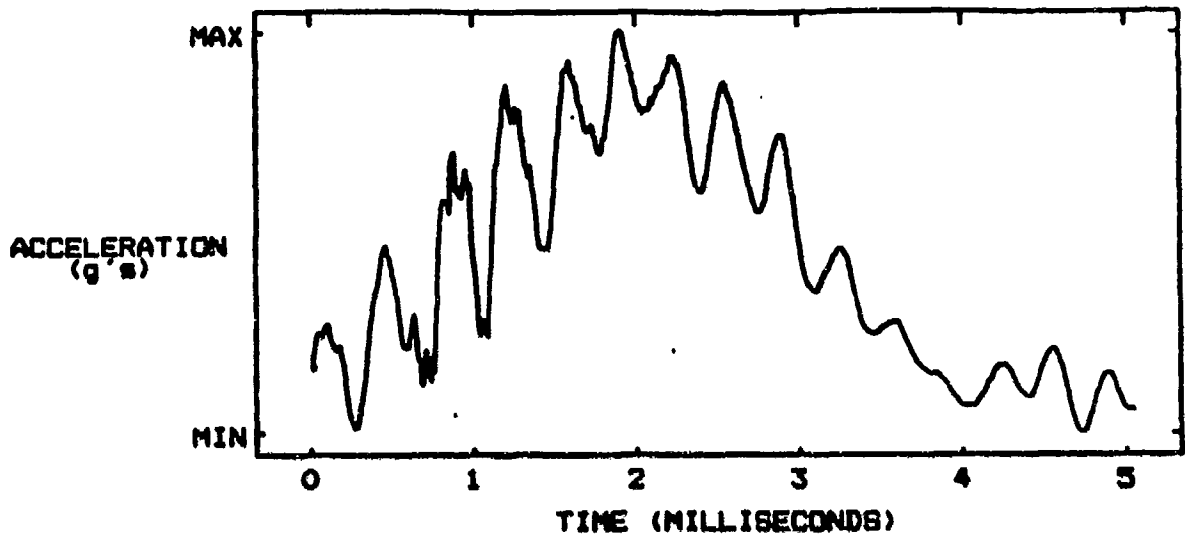
SPECIMEN I.D. 2-14-1

THICKNESS .111 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 23.3 IN

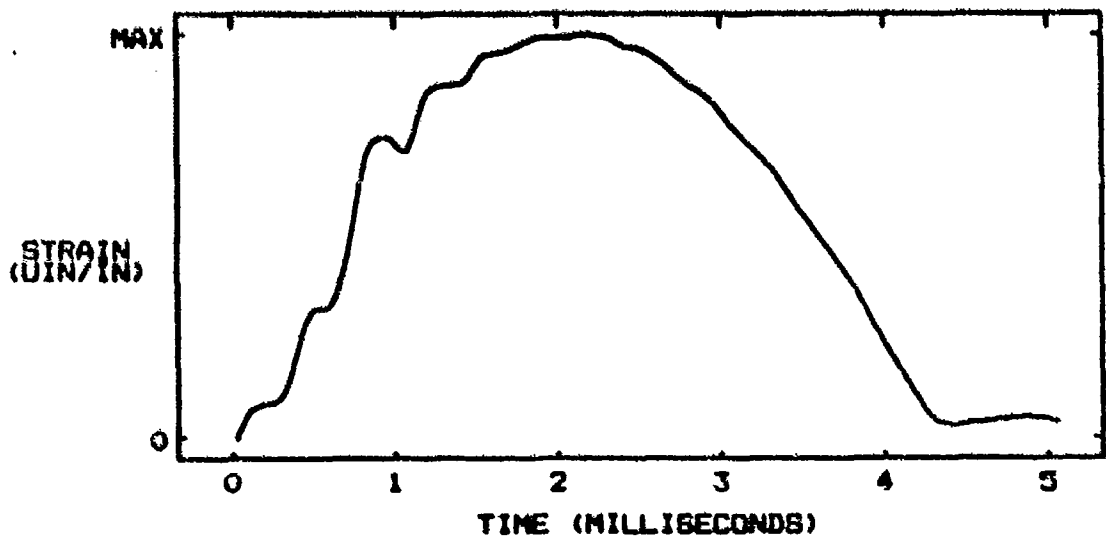
## ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -46 g's      MAXIMUM ACCELERATION 256 g's

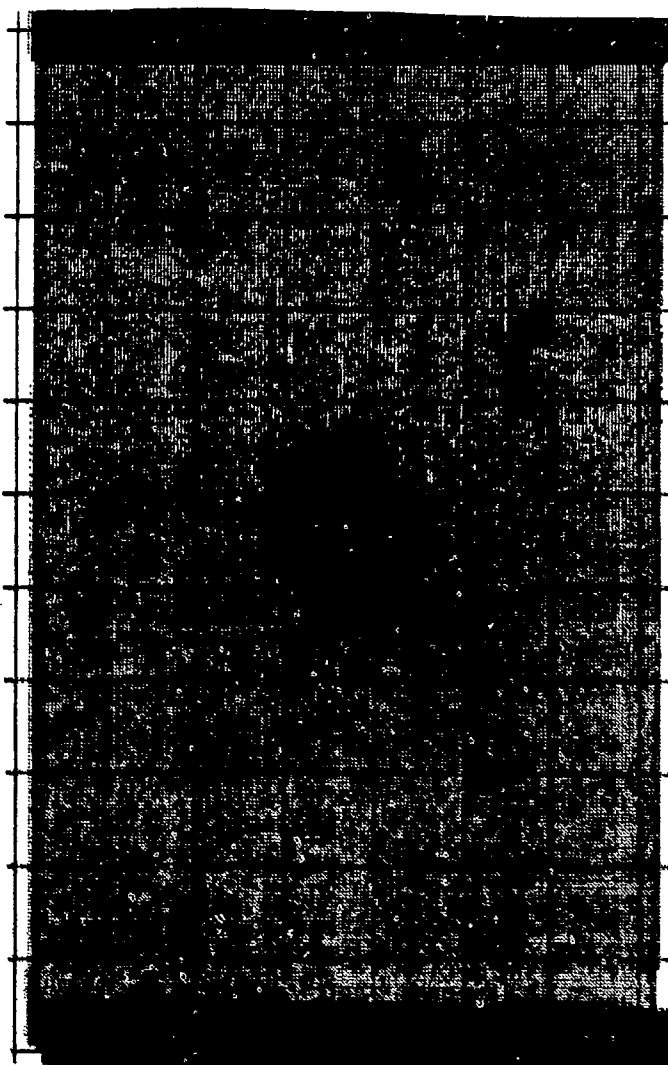
INTEGRATED TOTAL VELOCITY 161.5 IN/SEC

## PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14618 UIN/IN

Figure B-31. Panel 2-14-1 Impact Response Data



Specimen 2-14-1

Figure B-32. Panel 2-14-1 C-Scan

# CSAI — IM6/F650

PANEL 2-14-1 (RTD)

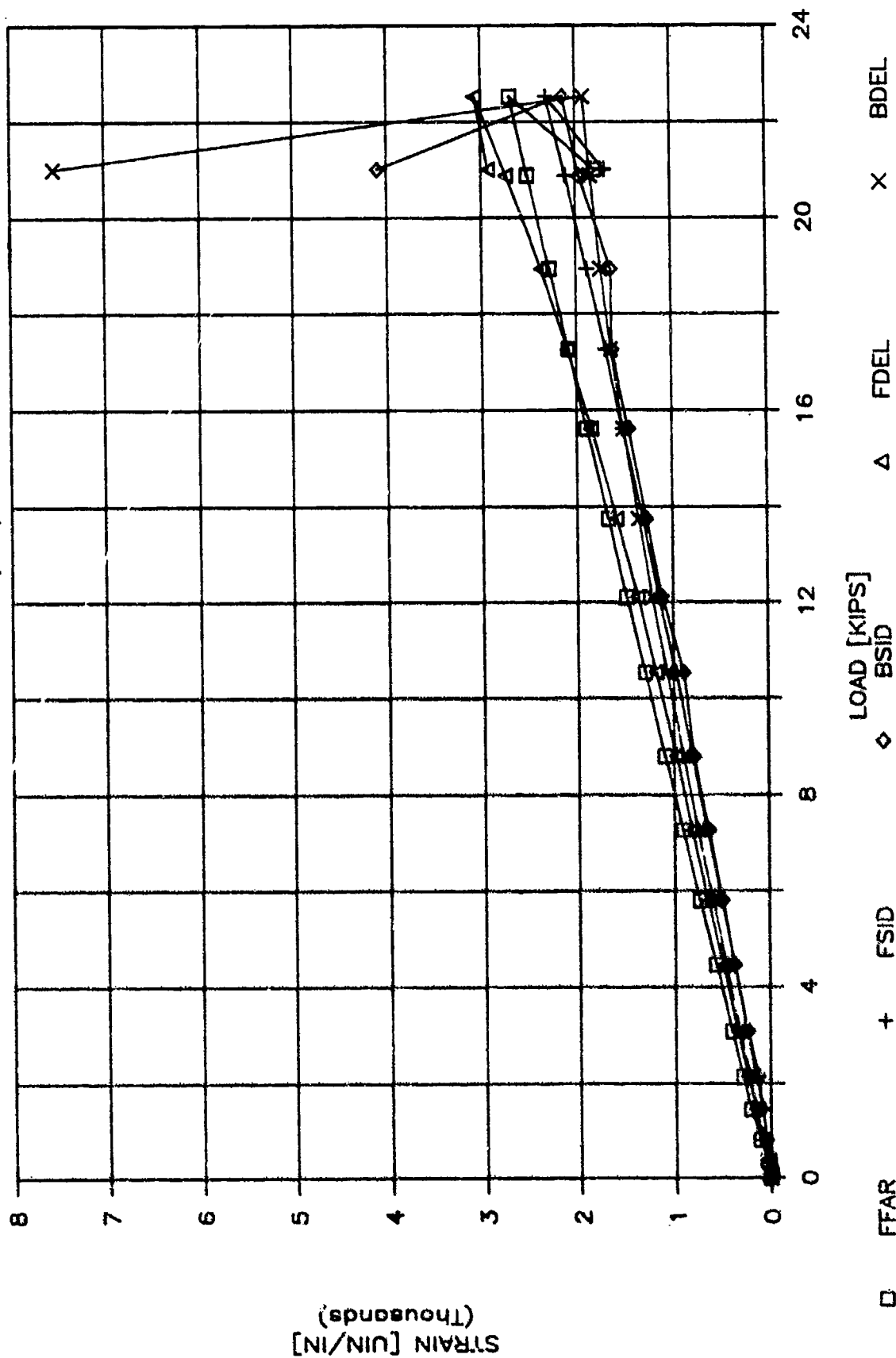


Figure B-33. Panel 2-14-1 Residual Compression Data

## LVLD SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

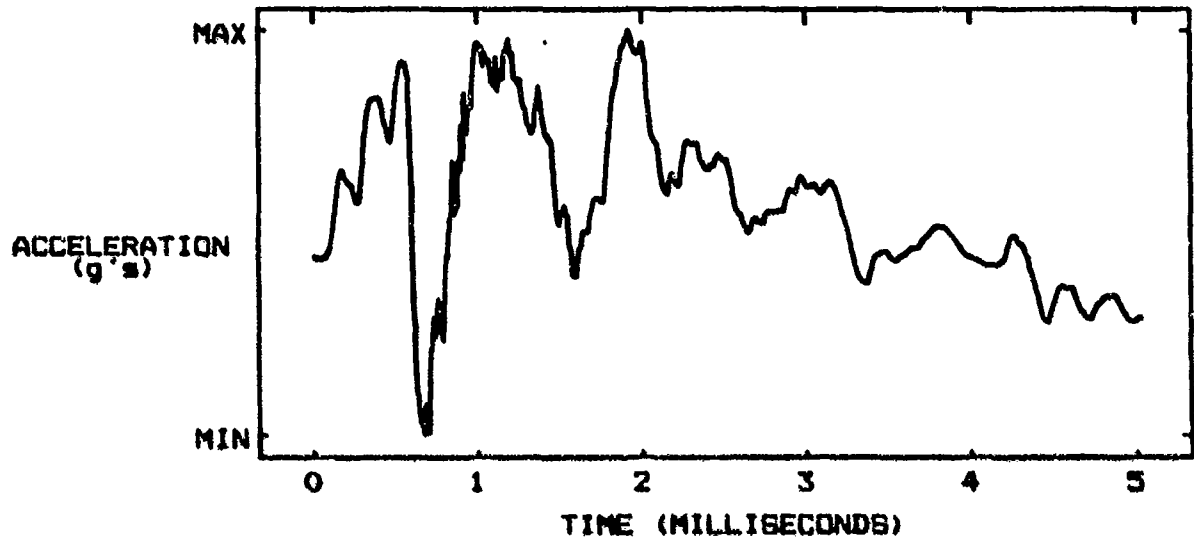
SPECIMEN I.D. 2-20-2

THICKNESS .219 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 16.3 IN

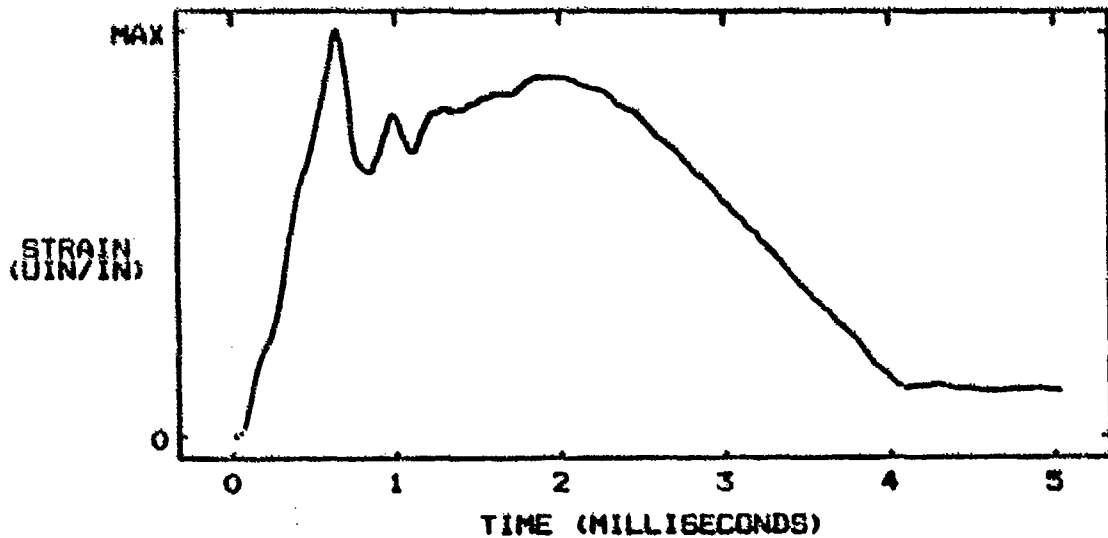
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -230 g's      MAXIMUM ACCELERATION 304.7 g's

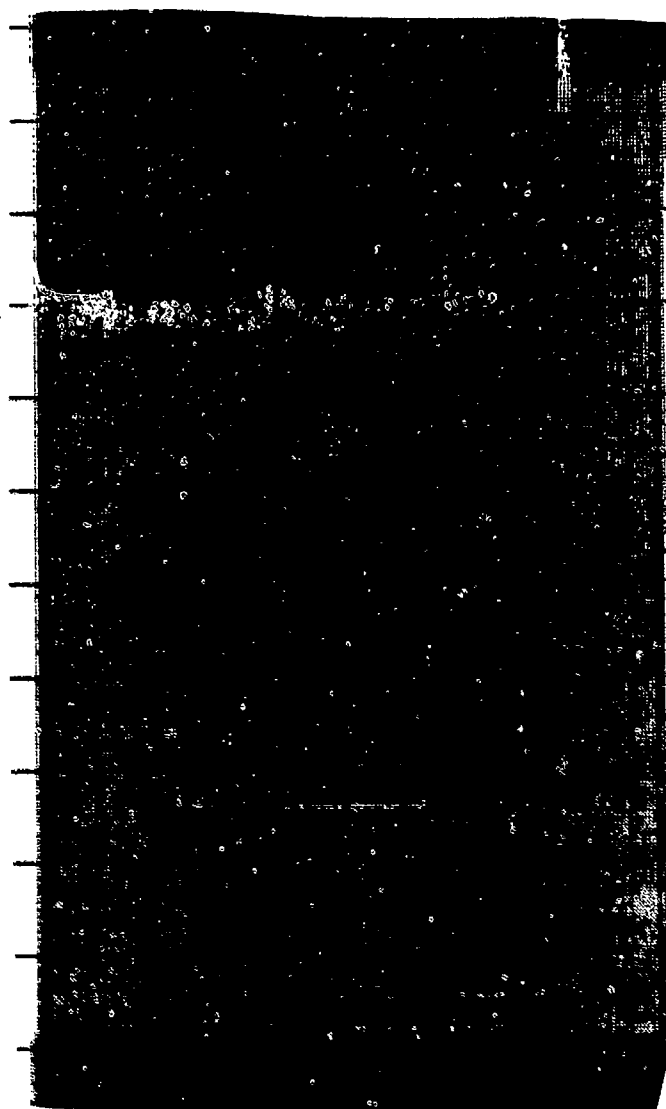
INTEGRATED TOTAL VELOCITY 150 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 4404.3 μIN/IN

Figure B-34. Panel 2-20-2 Impact Response Data



**Specimen 2-20-2**

**Figure B-35. Panel 2-20-2 C-Scan**

# CSA1 - IM6/F650

PANEL 2-20-2 (RTD)

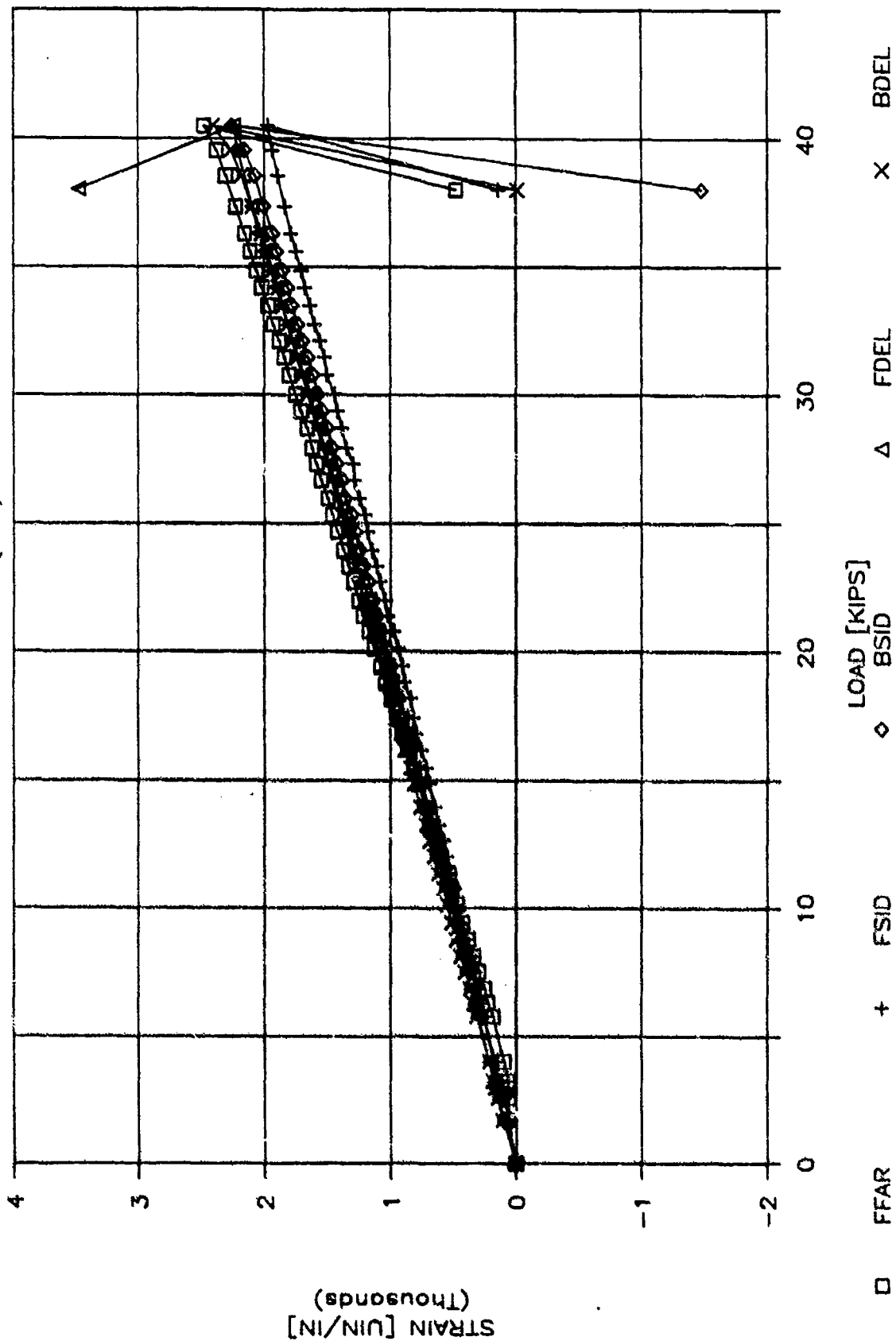


Figure B-36. Panel 2-20-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

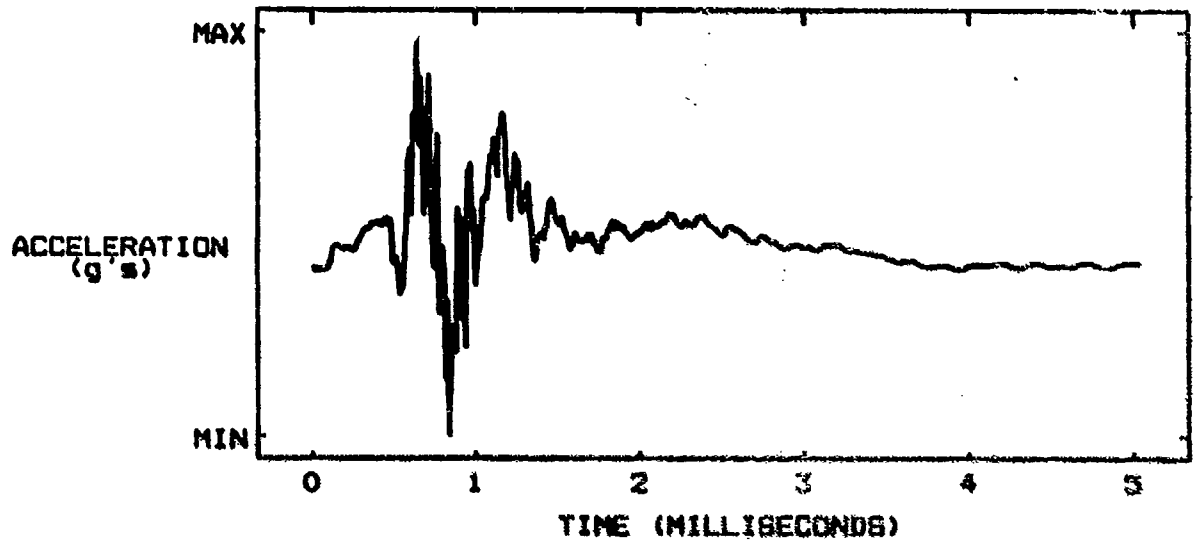
SPECIMEN I.D. 2-15-2

THICKNESS .443 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 23 IN

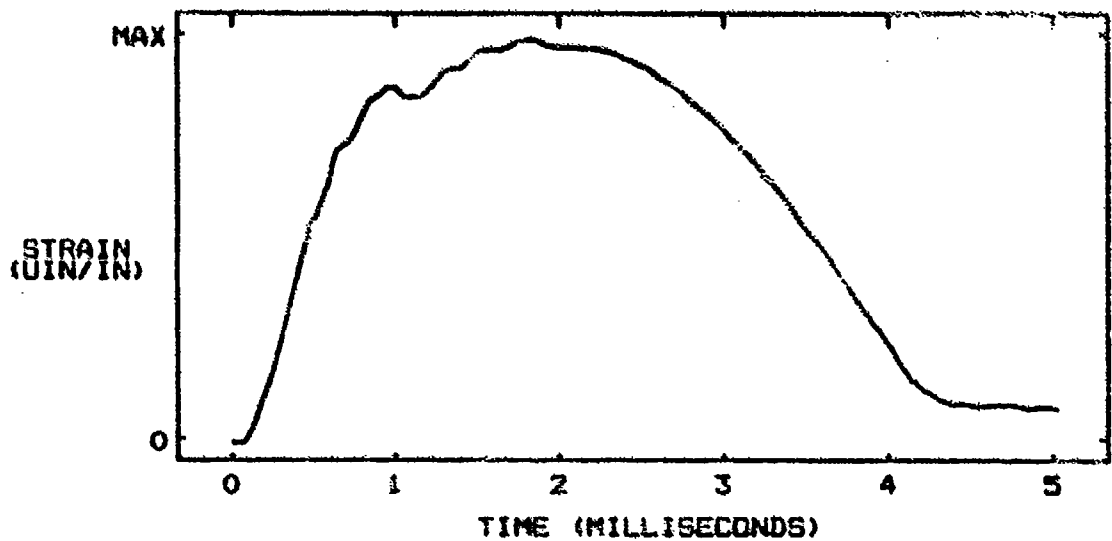
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -659 g's      MAXIMUM ACCELERATION 756 g's

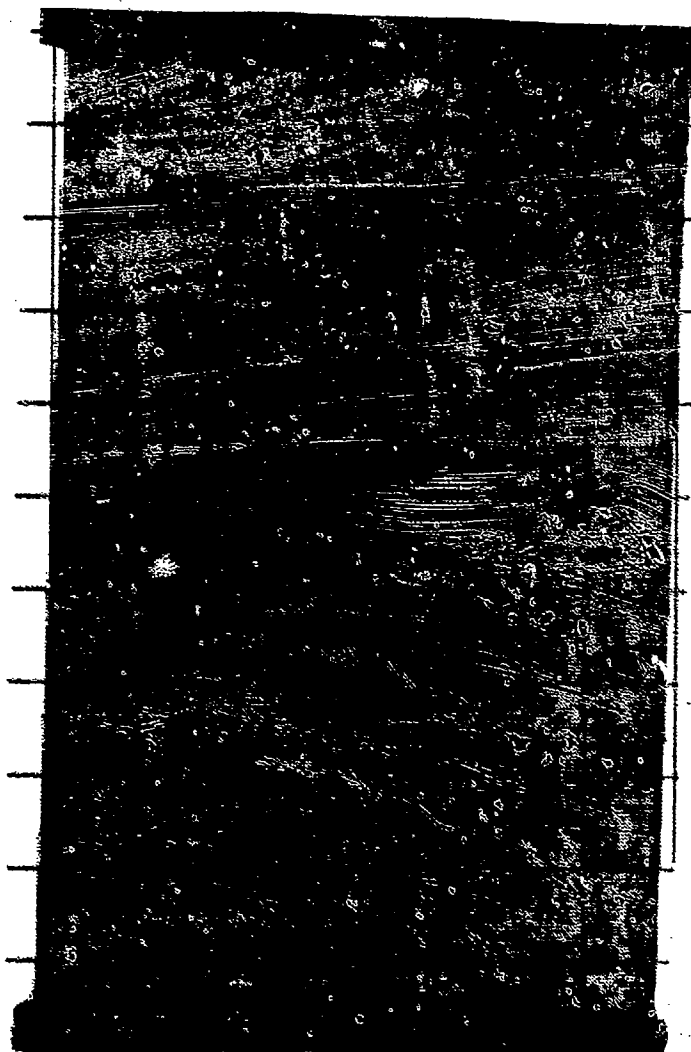
INTEGRATED TOTAL VELOCITY 202.49 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9343 UIN/IN

Figure B-37. Panel 2-15-2 Impact Response Data



**Specimen 2-15-2**

**Figure B-38. Panel 2-15-2 C-Scan**

# CSAI - IM6/F650

PANEL 2-15-2 (RTD)

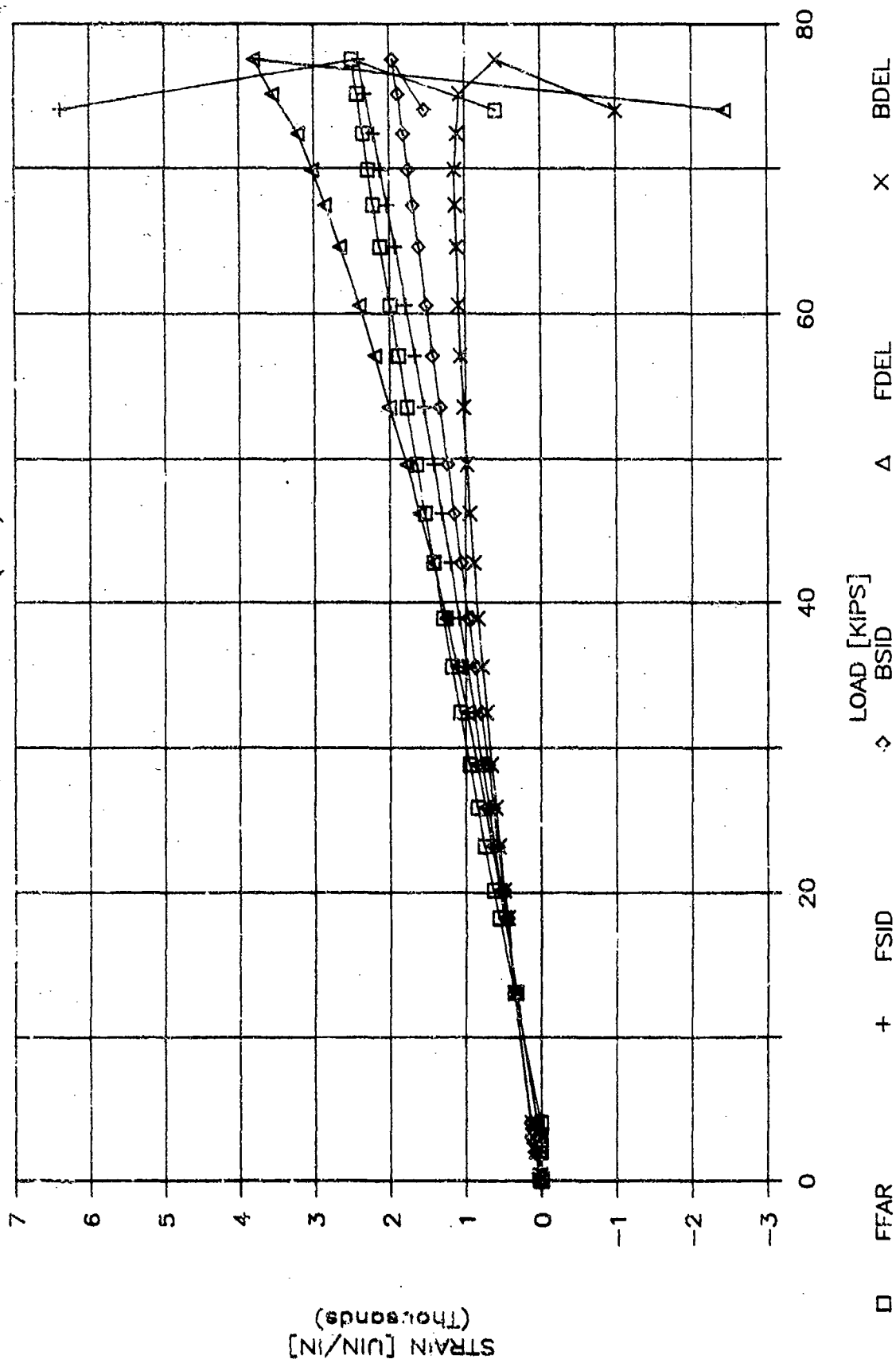


Figure B-39. Panel 2-15-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

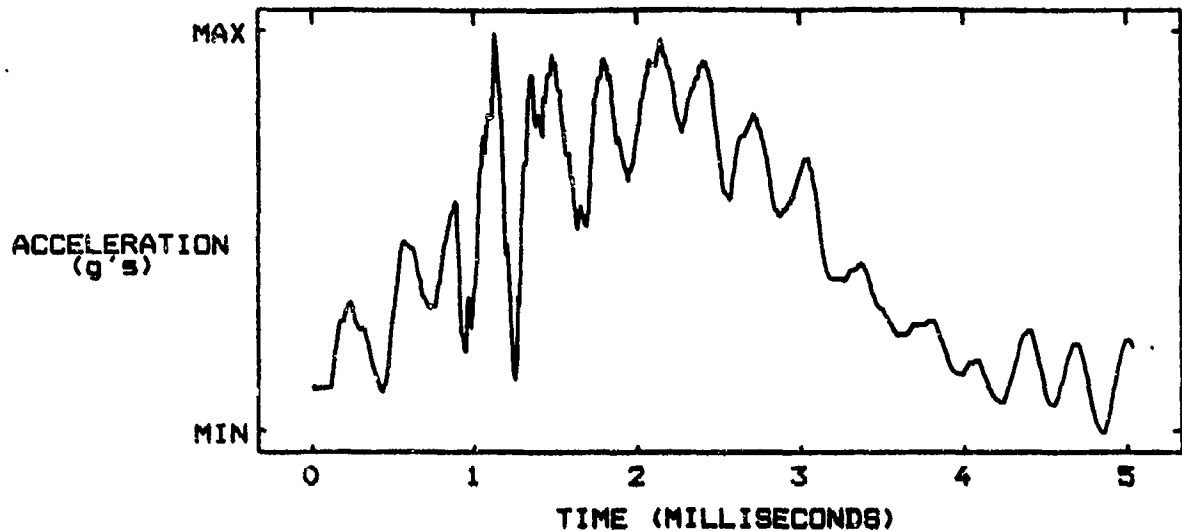
SPECIMEN I.D. 1-12-4

THICKNESS .114 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 26.7 IN

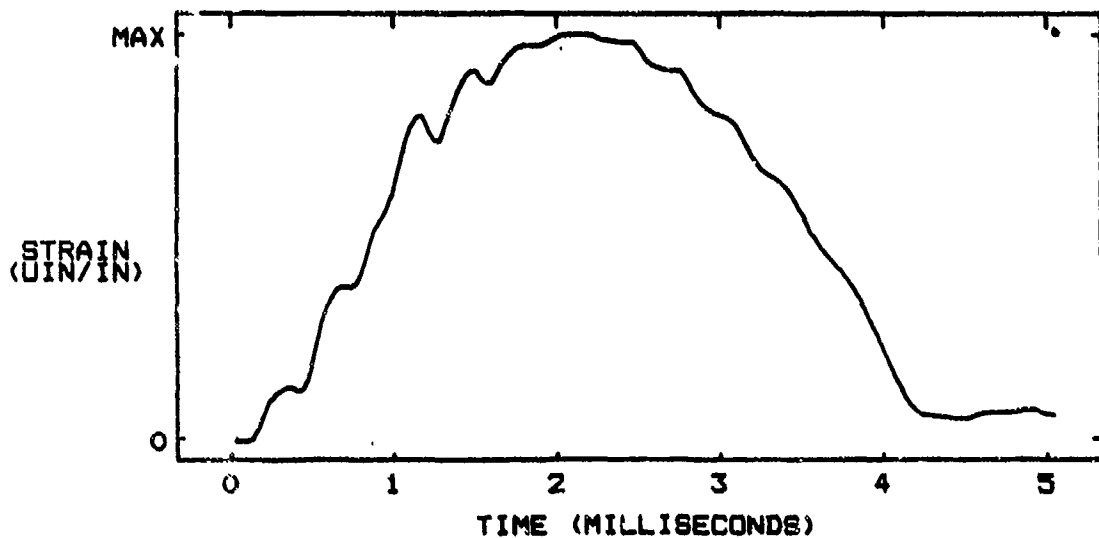
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -35.3 g's      MAXIMUM ACCELERATION 334.96 g's

INTEGRATED TOTAL VELOCITY 241.46 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 15068 UIN/IN

Figure B-40. Panel 1-12-4 Impact Response Data

# CSAI - IM6/3100

PANEL 1-12-4 (ETW)

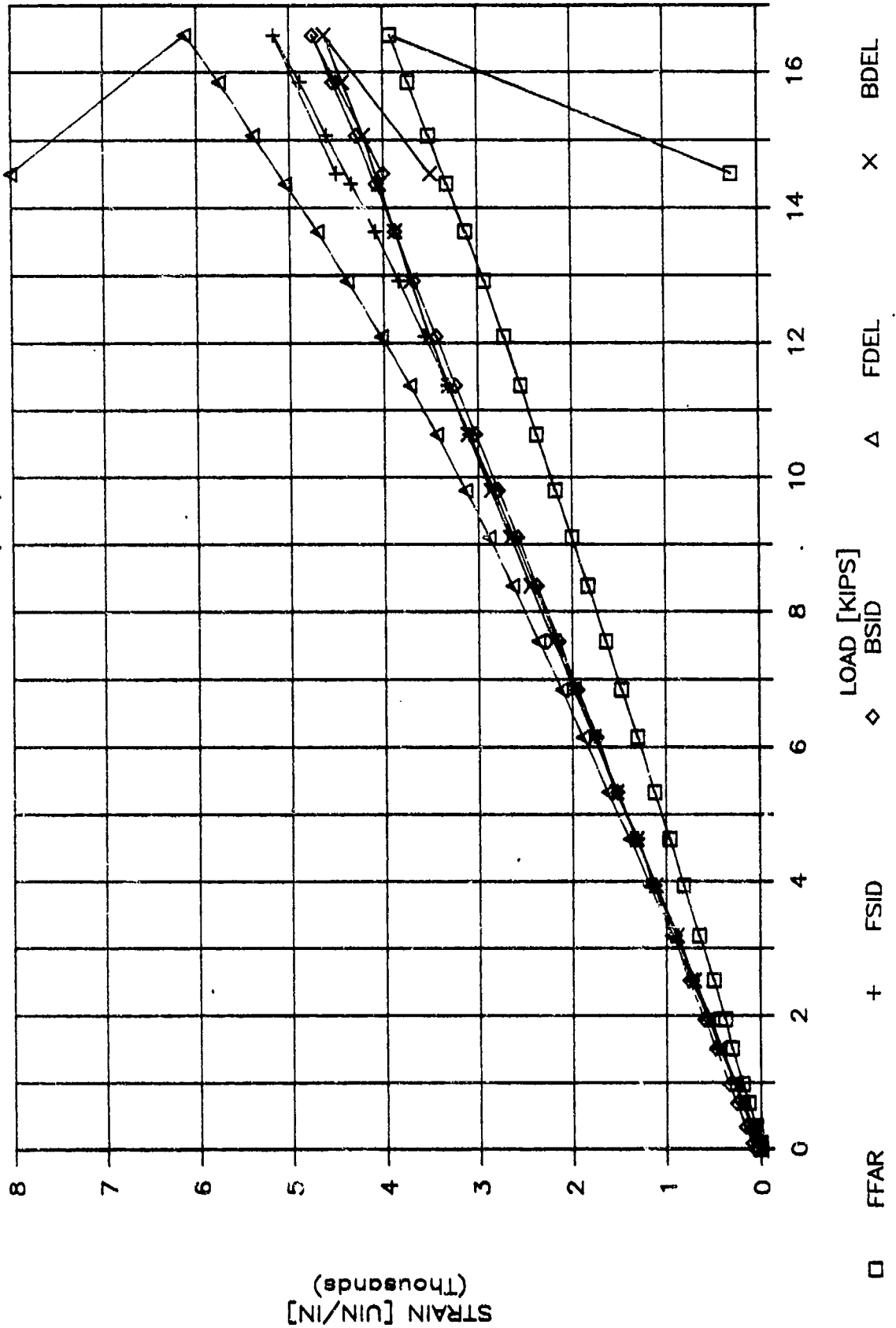


Figure B-41. Panel 1-12-4 Residual Compression Data

# LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

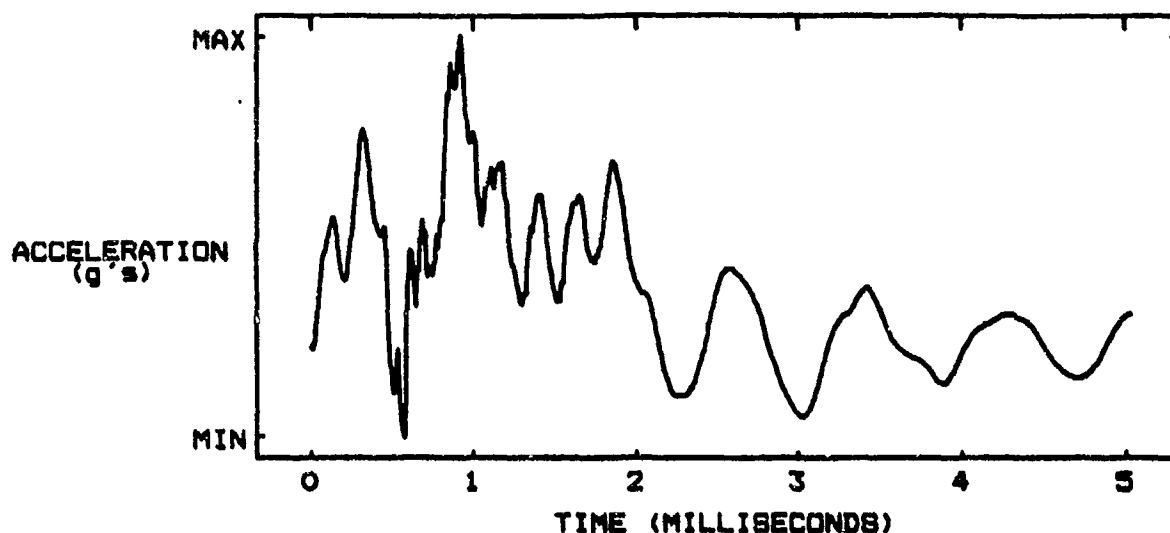
SPECIMEN I.D. 1-11-5

THICKNESS .222 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 46.7 IN

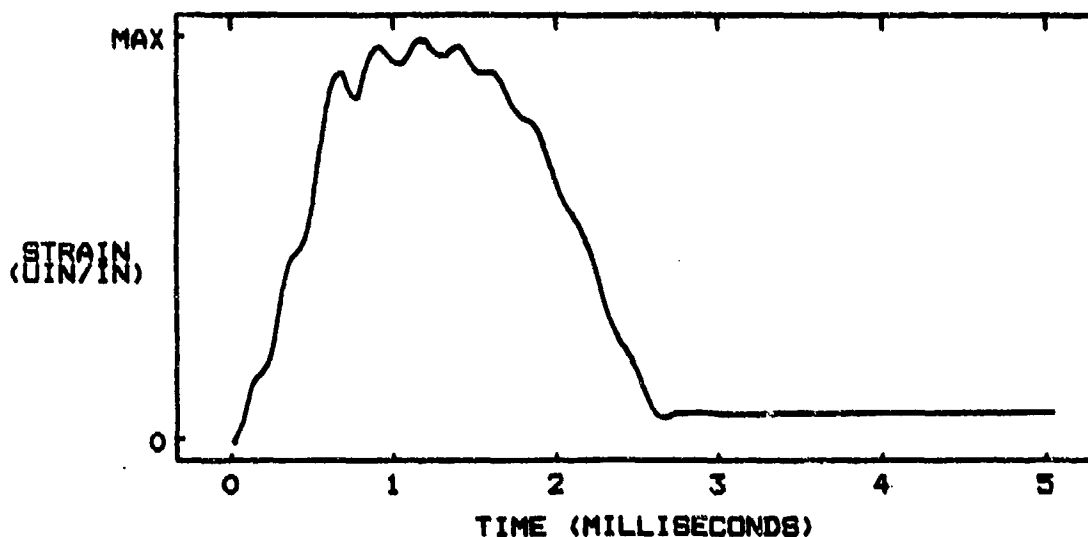
## ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -251 g's      MAXIMUM ACCELERATION 874 g's

INTEGRATED TOTAL VELOCITY 260.65 IN/SEC

## PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 15742 UIN/IN

Figure B-42. Panel 1-11-5 Impact Response Data

# CSAI - IM6/3100

PANEL 1-11-5 (ETW)

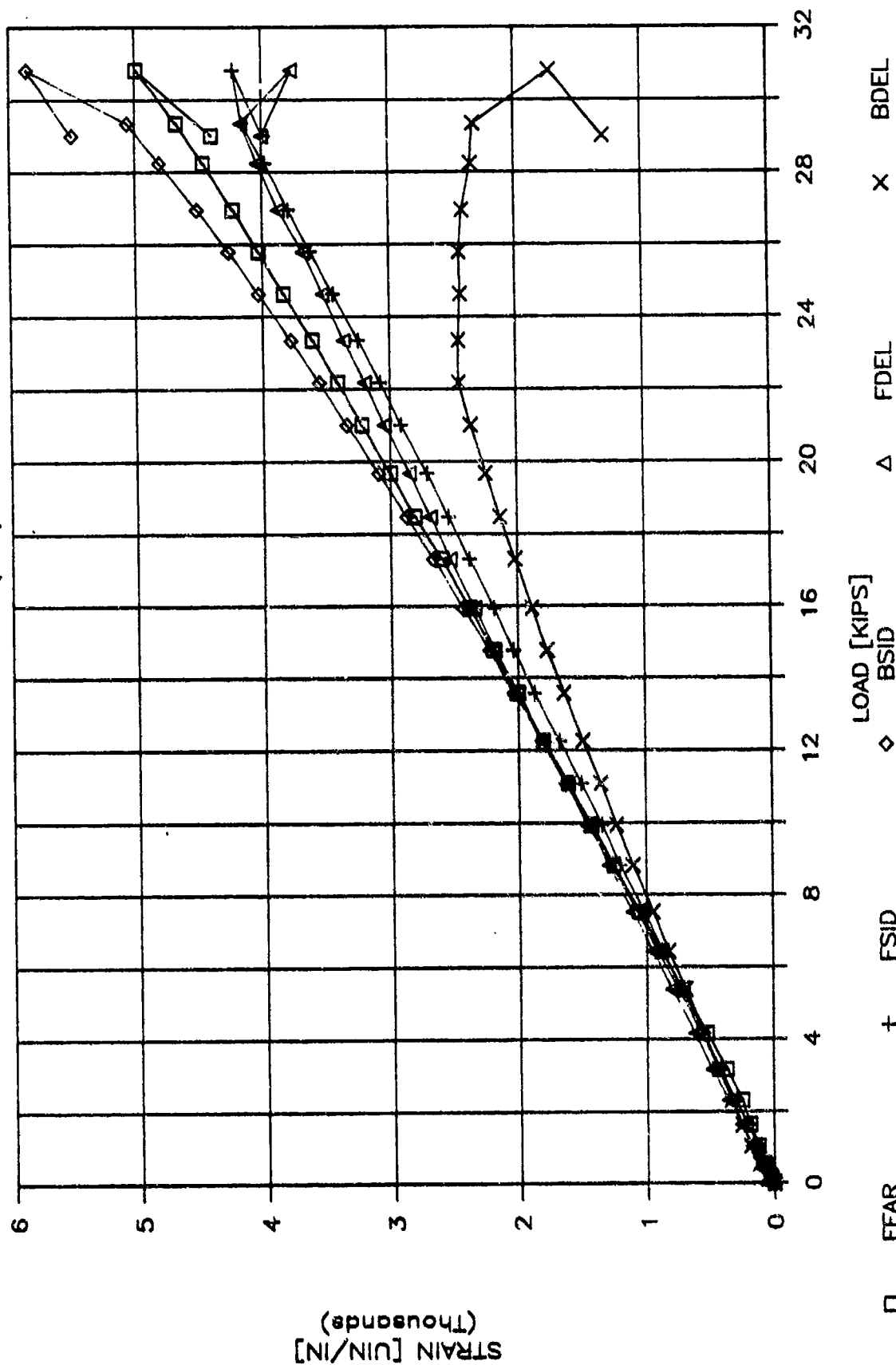


Figure B-43. Panel 1-11-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

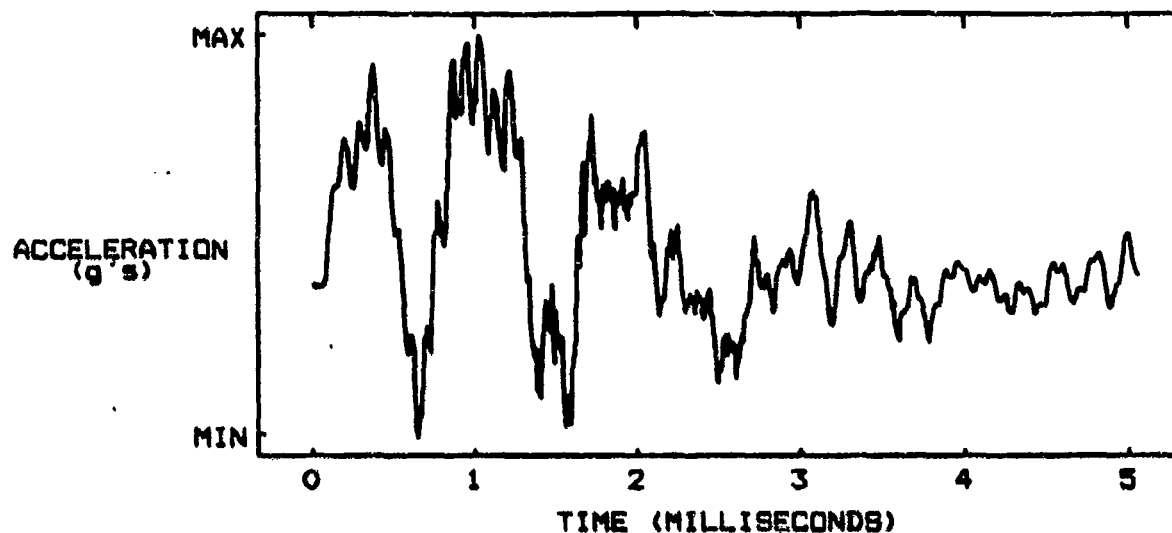
SPECIMEN I.D. 1-13-4

THICKNESS .449 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 37.5 IN

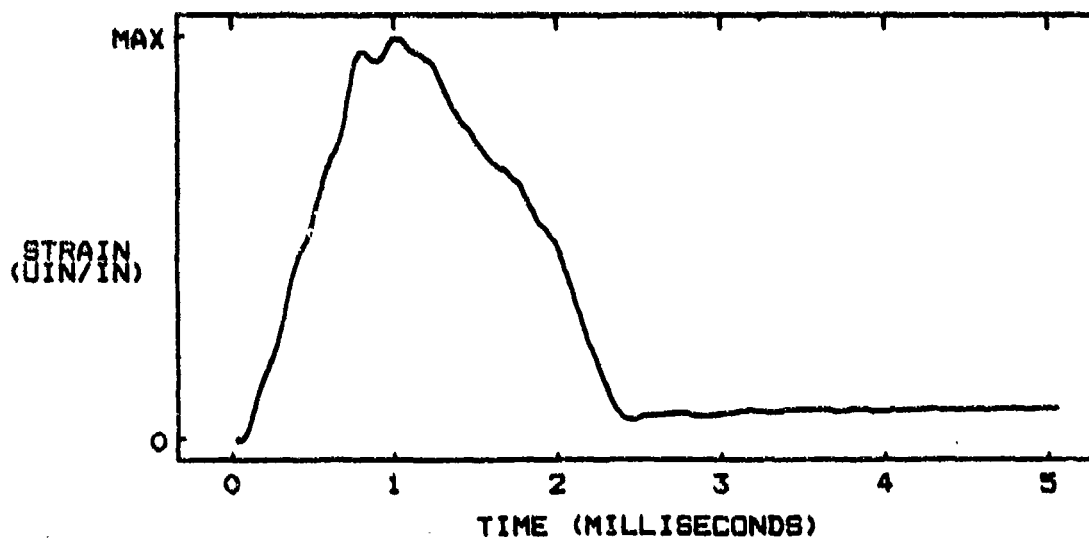
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -656 g's      MAXIMUM ACCELERATION 1076 g's

INTEGRATED TOTAL VELOCITY 257.6 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 10580 UIN/IN

Figure B-44. Panel 1-13-4 Impact Response Data

# CSAI - IM6/3100

PANEL 1-13-4 (ETW)

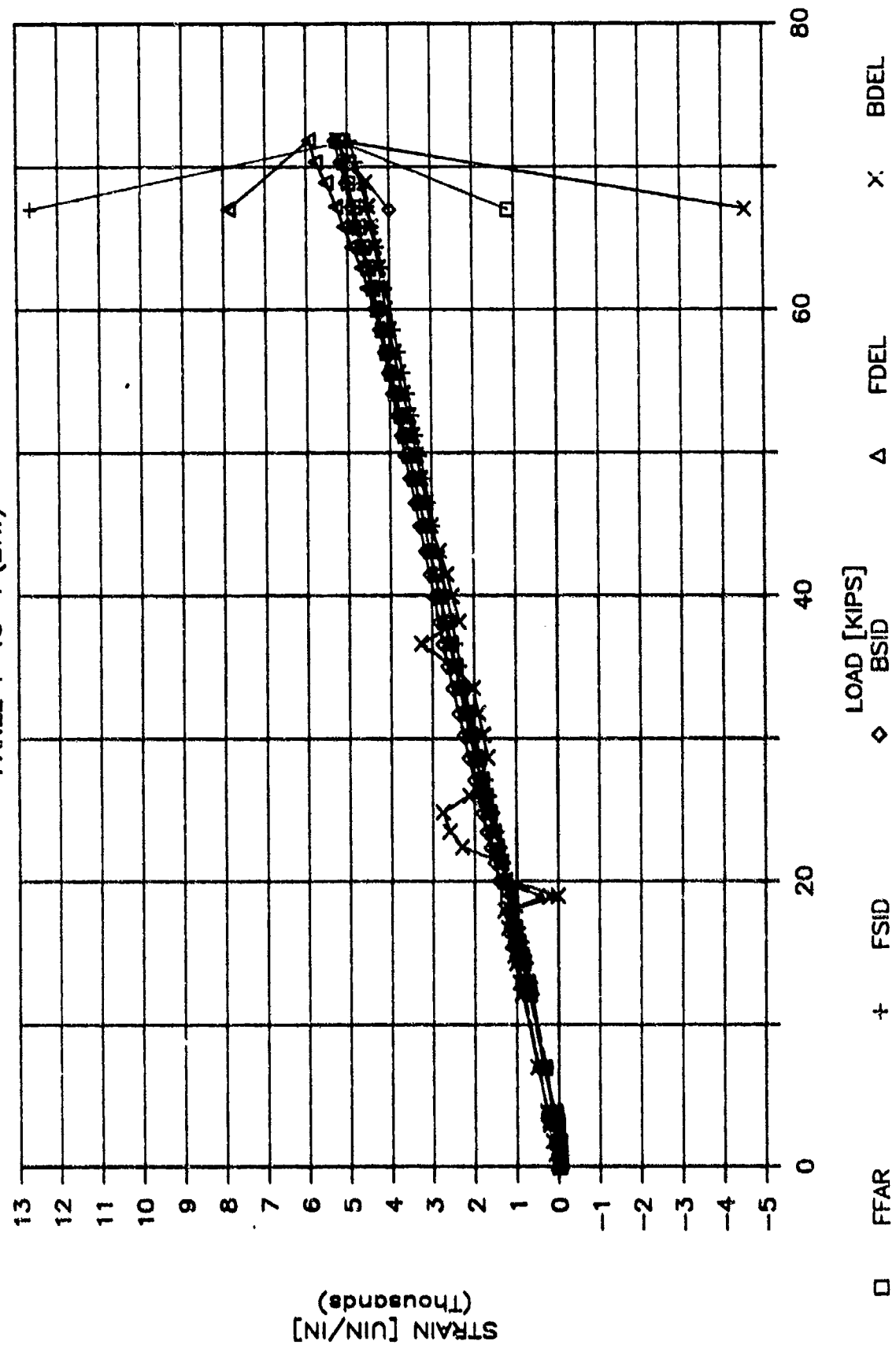


Figure B-45. Panel 1-13-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

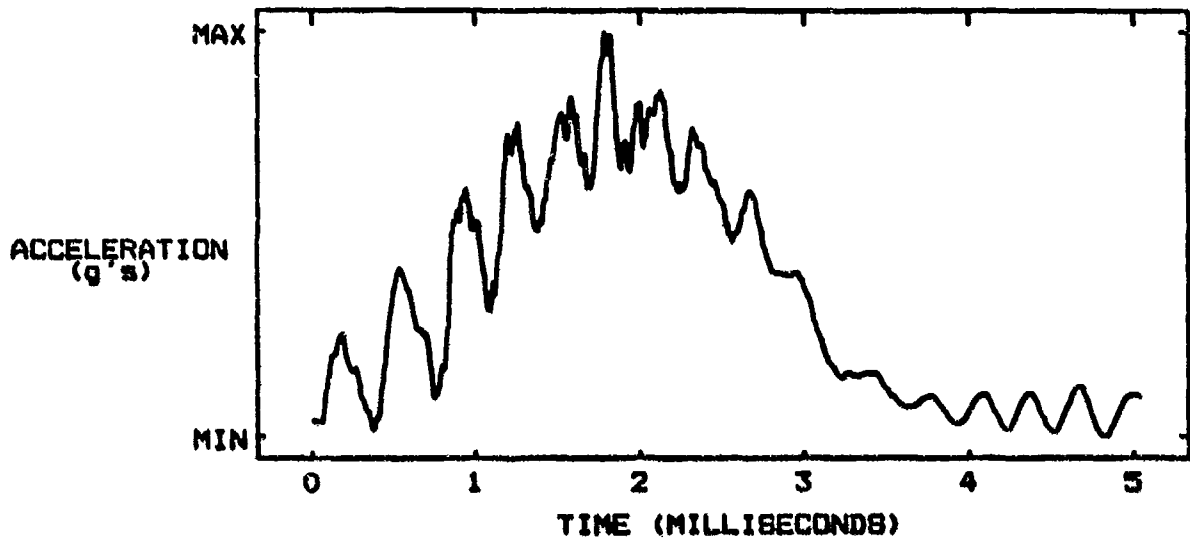
SPECIMEN I.D. 1-14-4

THICKNESS .110 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 46.7 IN

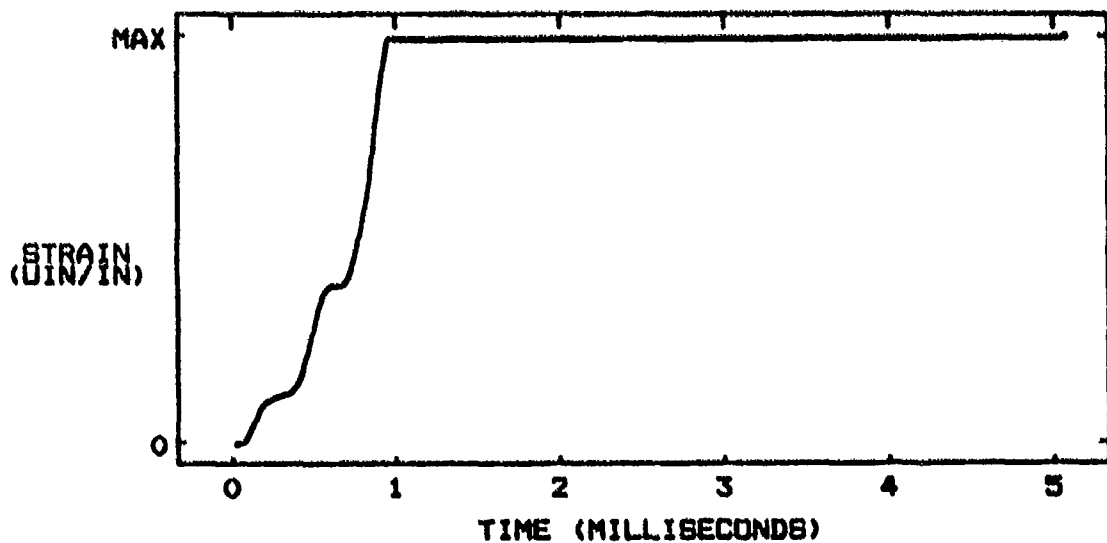
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -21 g's      MAXIMUM ACCELERATION 462 g's

INTEGRATED TOTAL VELOCITY 276.79 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 18160 μIN/IN

Figure B-46. Panel 1-14-4 Impact Response Data

# CSAI - IM6/3100

PANEL 1-14-4 (ETW)

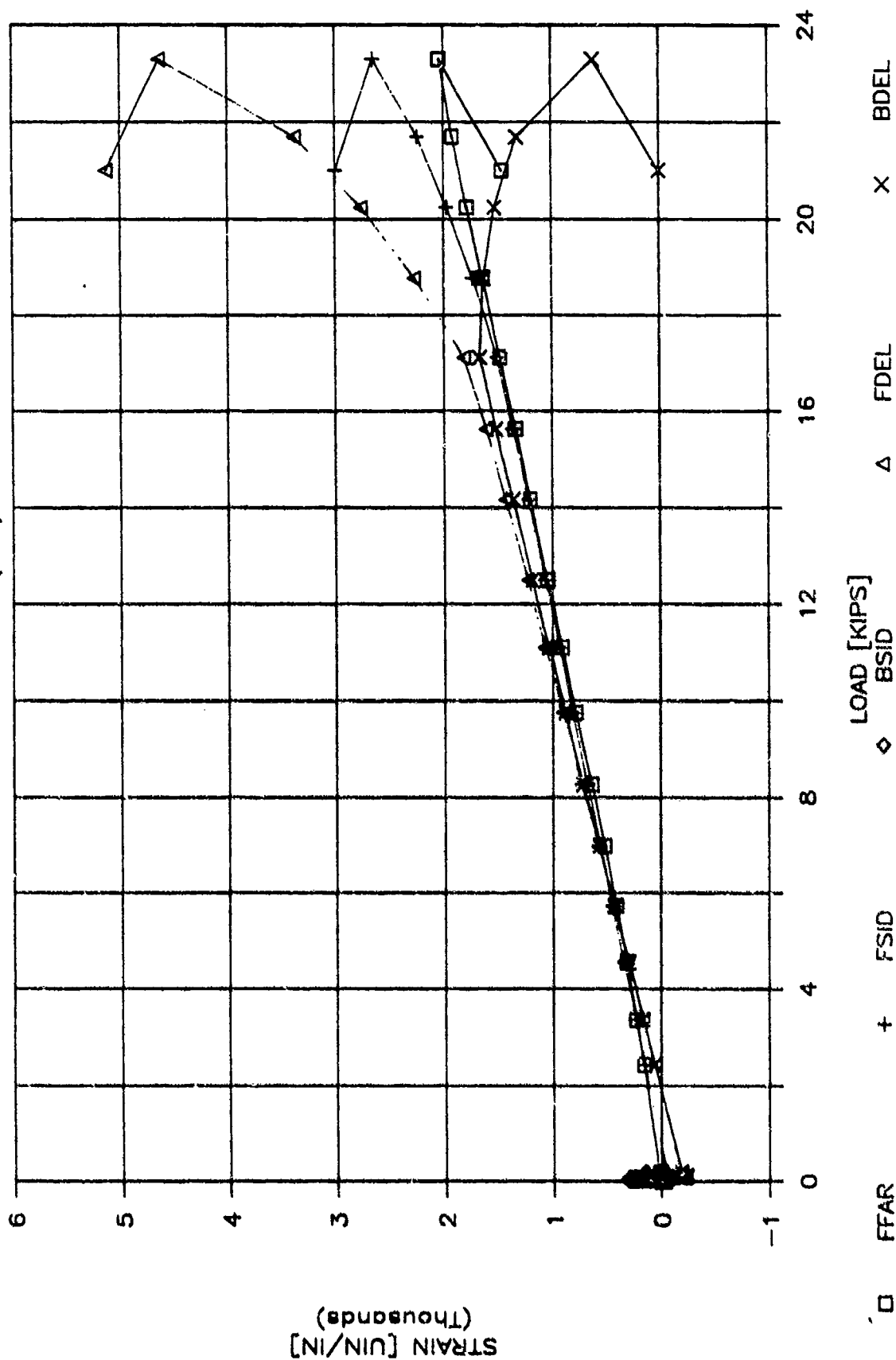


Figure B-47. Panel 1-14-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

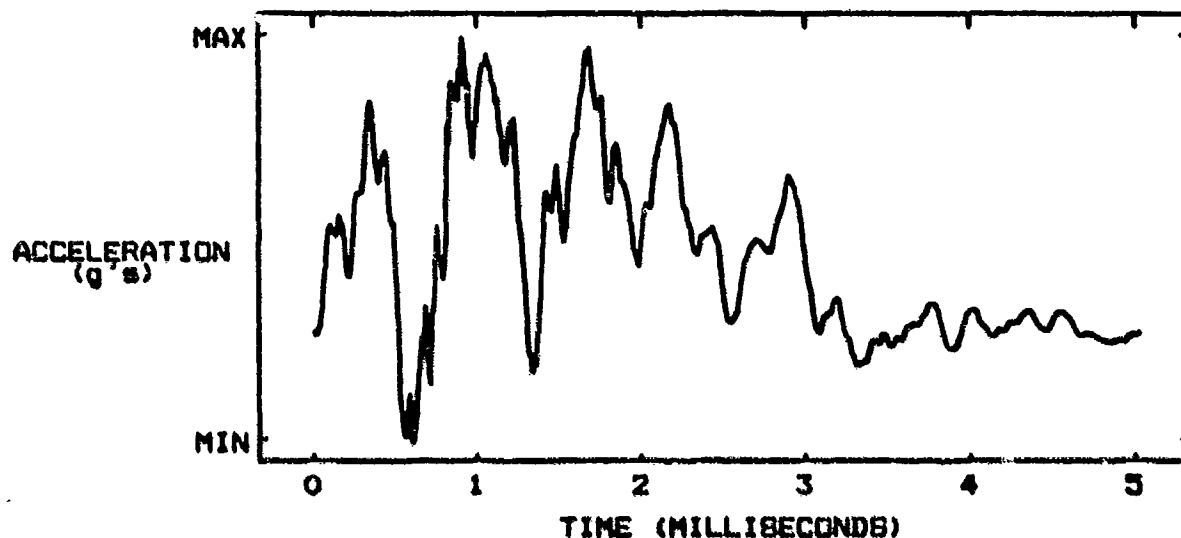
SPECIMEN I.D. 1-20-4

THICKNESS .225 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 37.5 IN

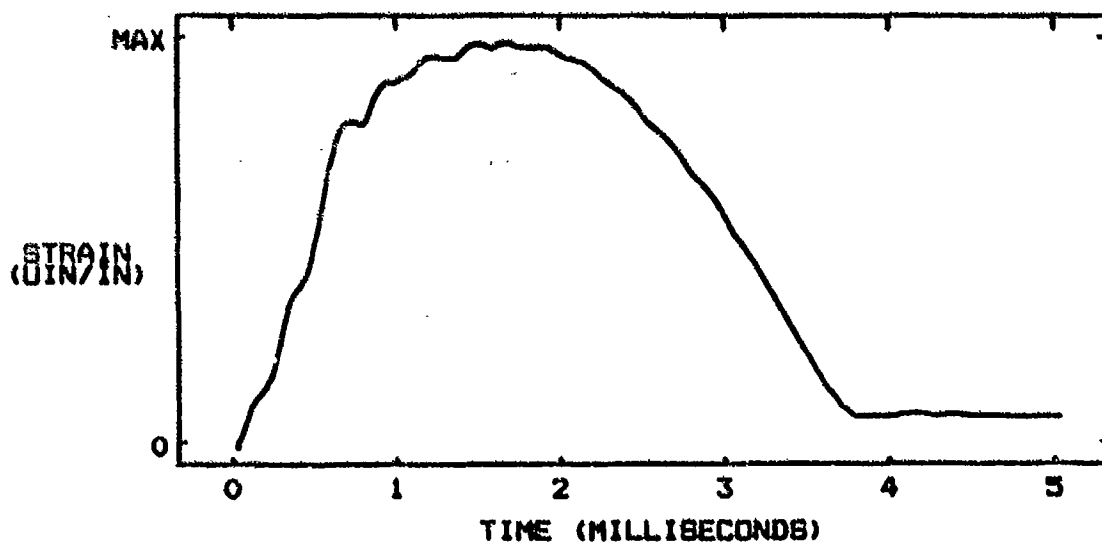
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -191 g's      MAXIMUM ACCELERATION 520 g's

INTEGRATED TOTAL VELOCITY 252.85 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14543  $\mu$ IN/IN

Figure B-48. Panel 1-20-4 Impact Response Data

# CSAI - IM6/3100

PANEL 1-20-4 (ETW)

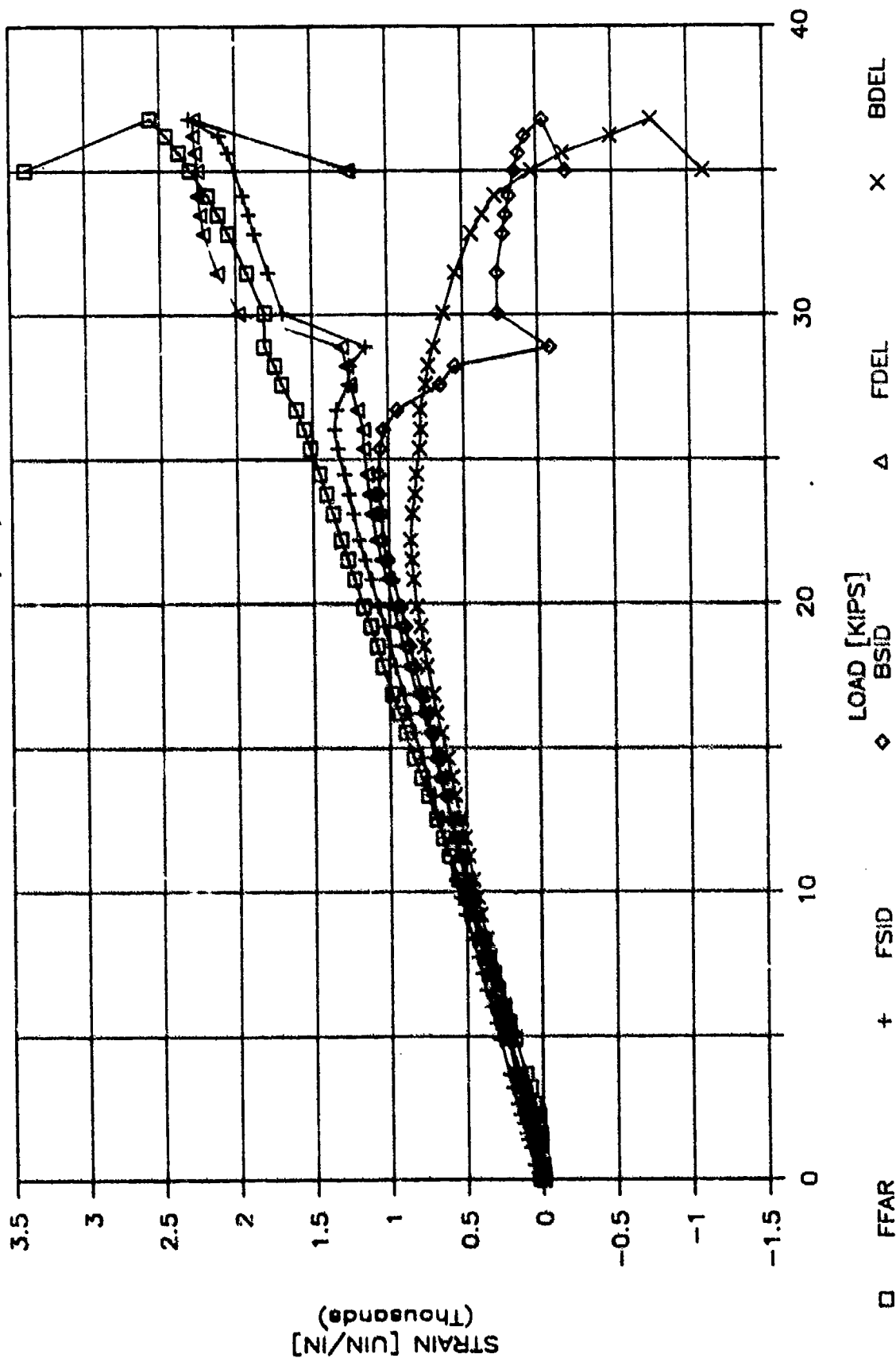


Figure B-49. Panel 1-20-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

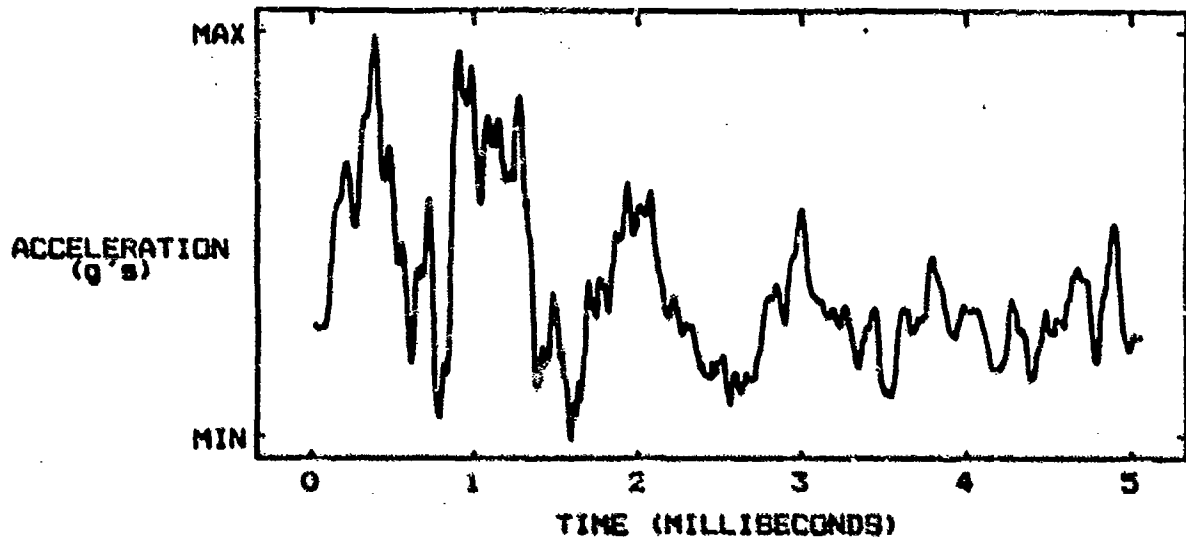
SPECIMEN I.D. 1-15-4.1

THICKNESS .451 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 37.5 IN

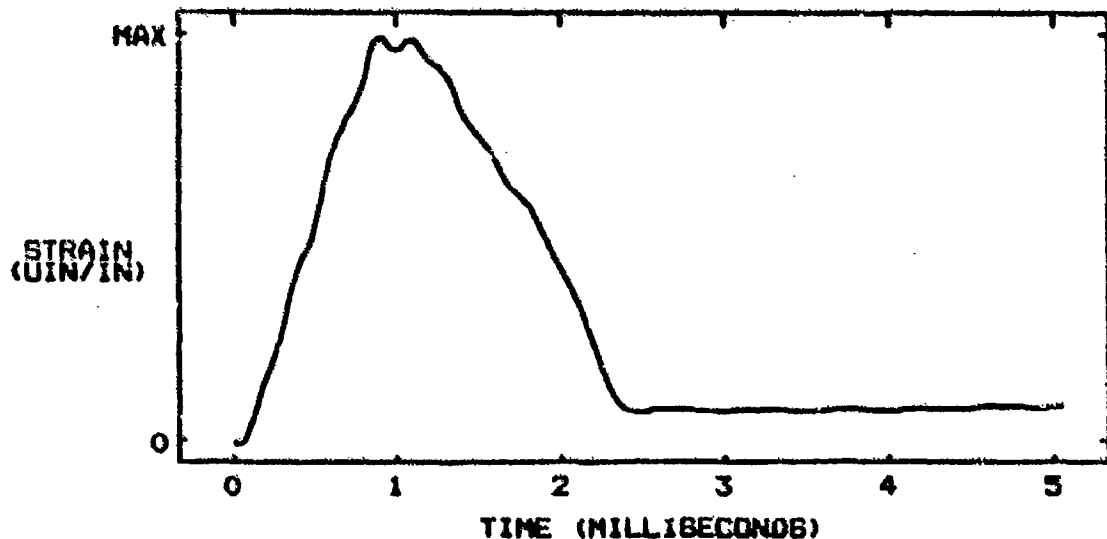
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -375 g's      MAXIMUM ACCELERATION 962.9 g's

INTEGRATED TOTAL VELOCITY 230.37 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9108 UIN/IN

Figure B-50. Panel 1-15-4 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

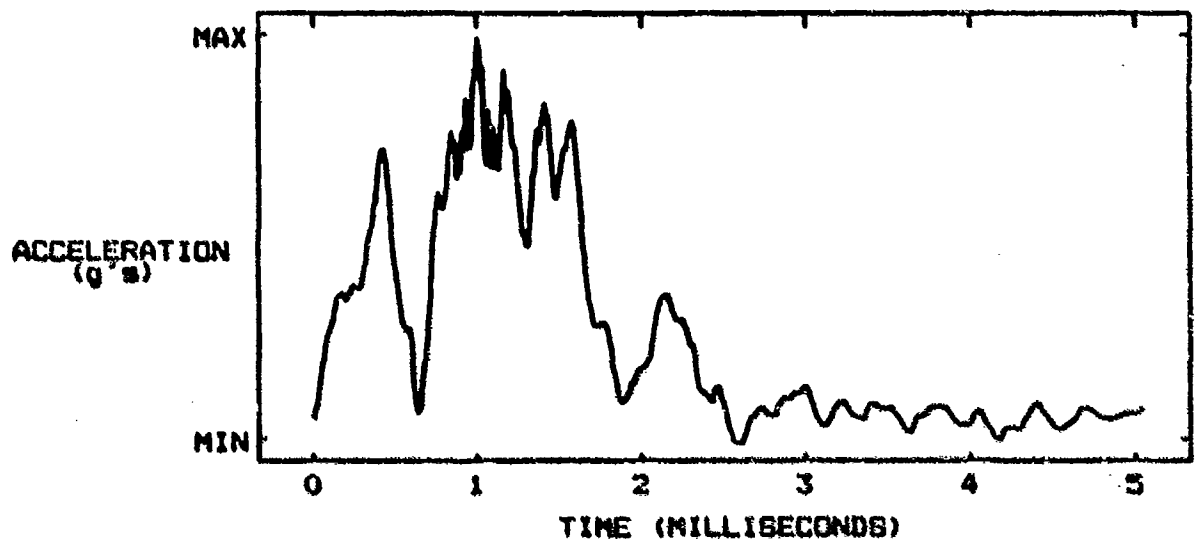
SPECIMEN I.D. 1-15-4.2

THICKNESS .451 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 37.5 IN

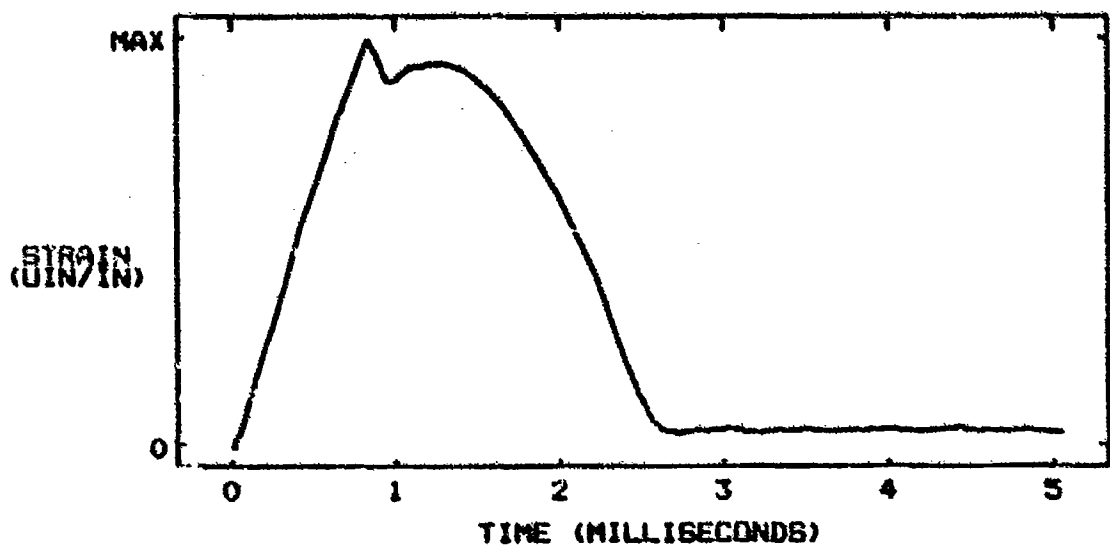
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -37 g's      MAXIMUM ACCELERATION 583.9 g's

INTEGRATED TOTAL VELOCITY 232.58 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9520 μIN/IN

Figure B-51. Panel 1-15-4 Second Impact Response Data

# CSA1 - IM6/3100

PANEL 1-15-4 (ETW)

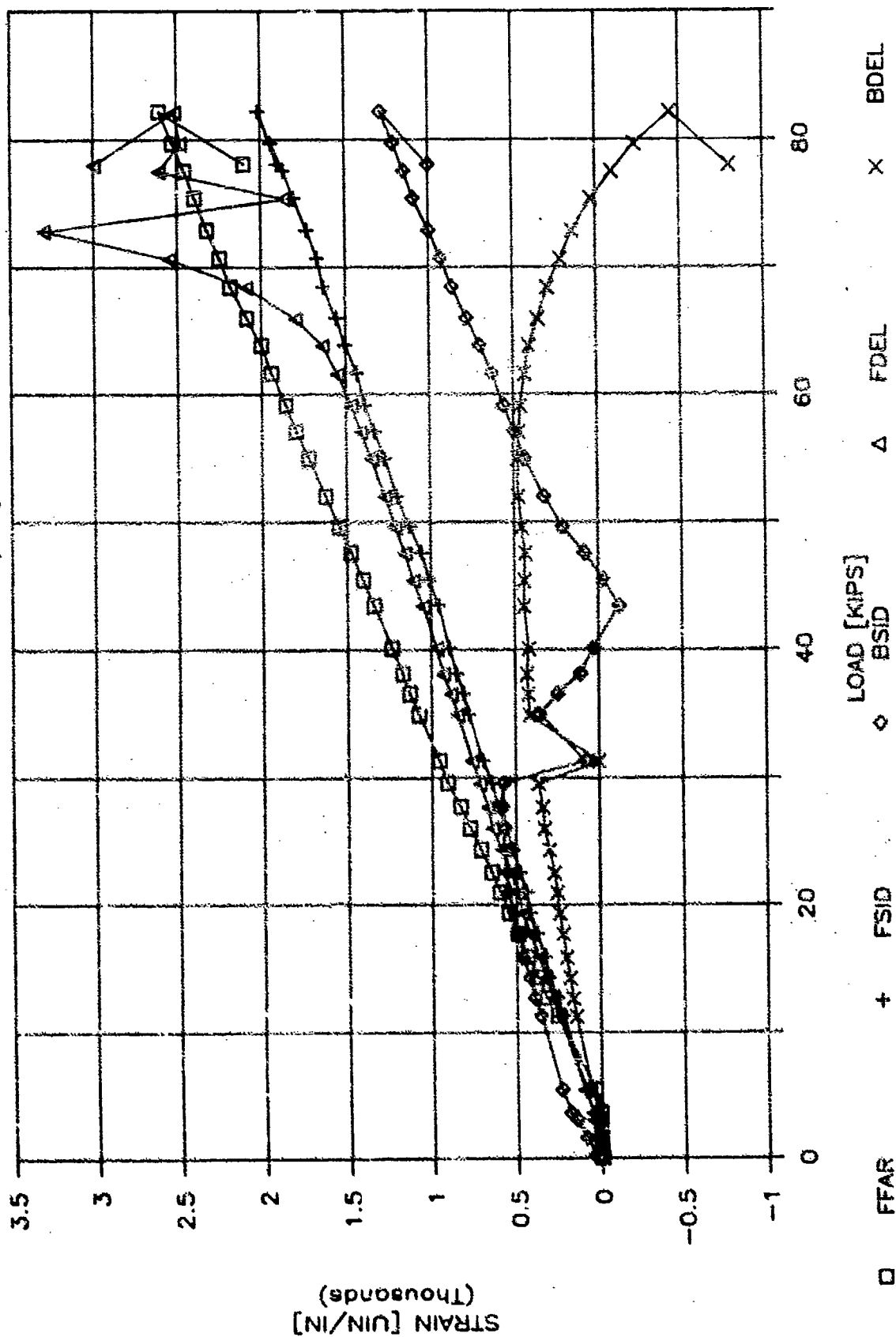


Figure 8-52. Panel 1-15-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

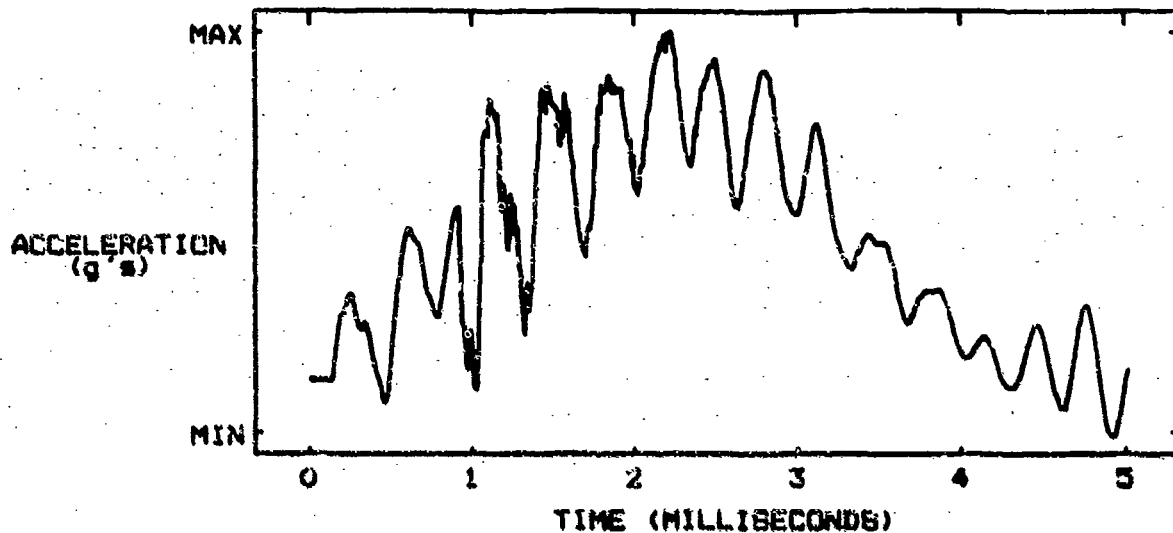
SPECIMEN I.D. 2-12-5

THICKNESS .106 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 20.0 IN

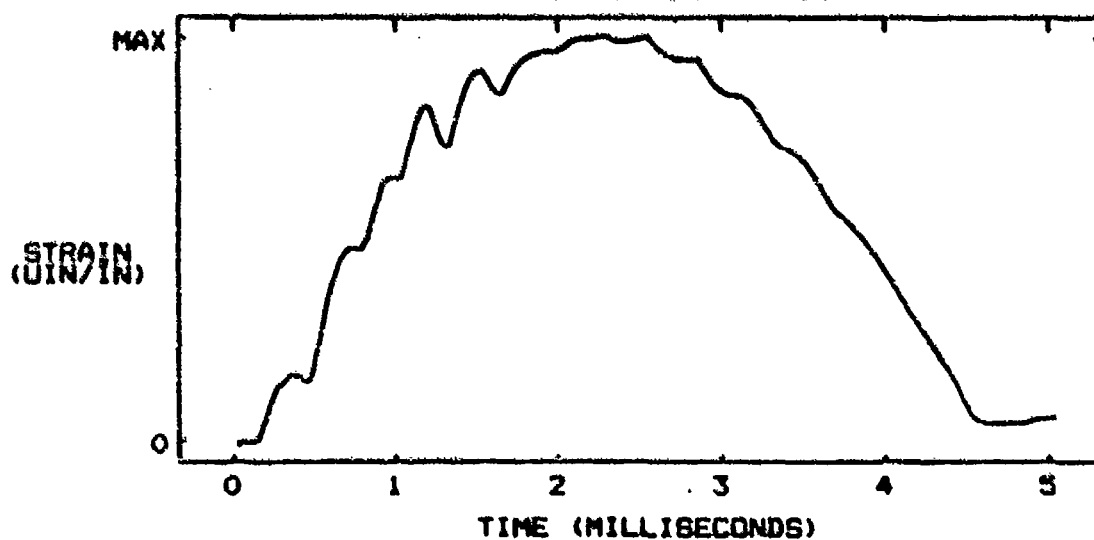
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -44 g's      MAXIMUM ACCELERATION 256.84 g's

INTEGRATED TOTAL VELOCITY 187 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 10833 UIN/IN

Figure B-53. Panel 2-12-5 Impact Response Data

# CSA1 - IM6/F650

PANEL 2-12-5 (ETW)

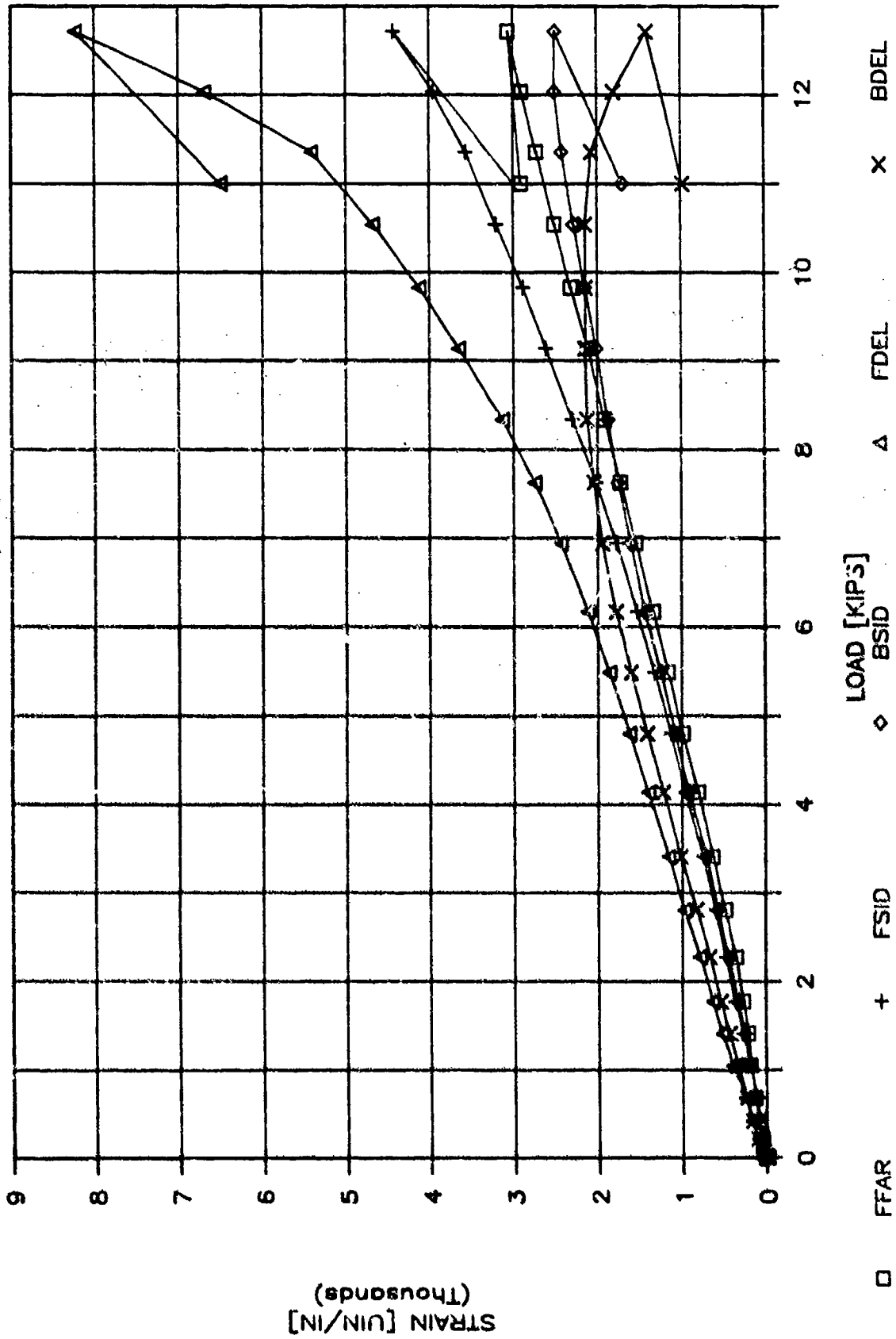


Figure B-54. Panel 2-12-5 Residual Compression Data

## LVTD SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

SPECIMEN I.D. 2-11-6

THICKNESS .216 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 23.3 IN

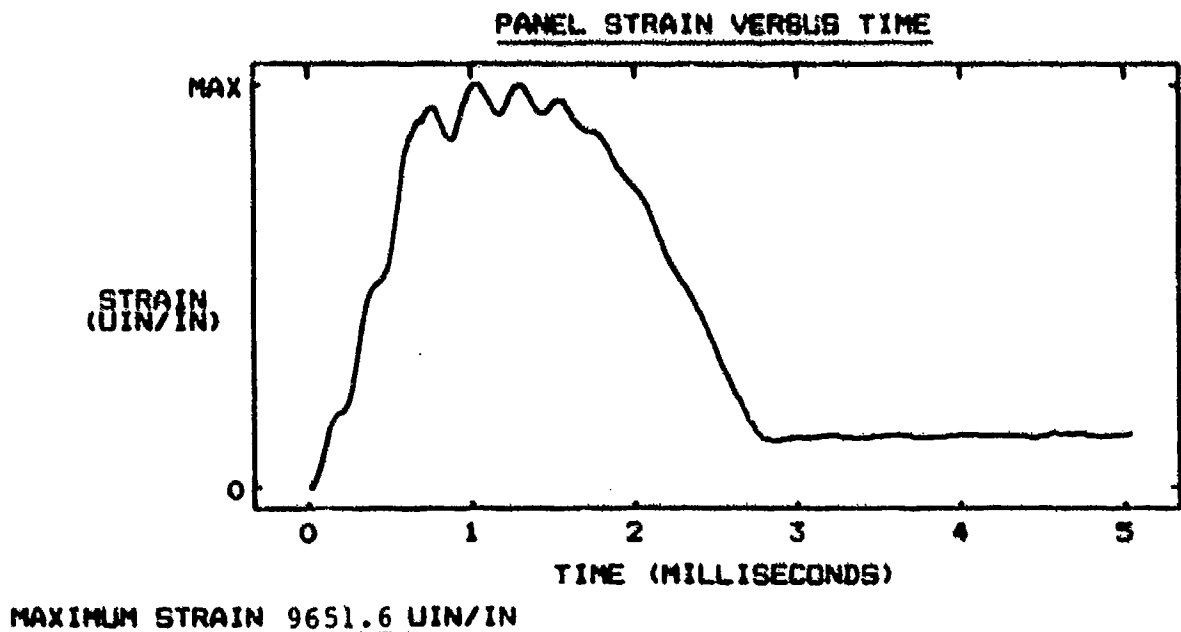
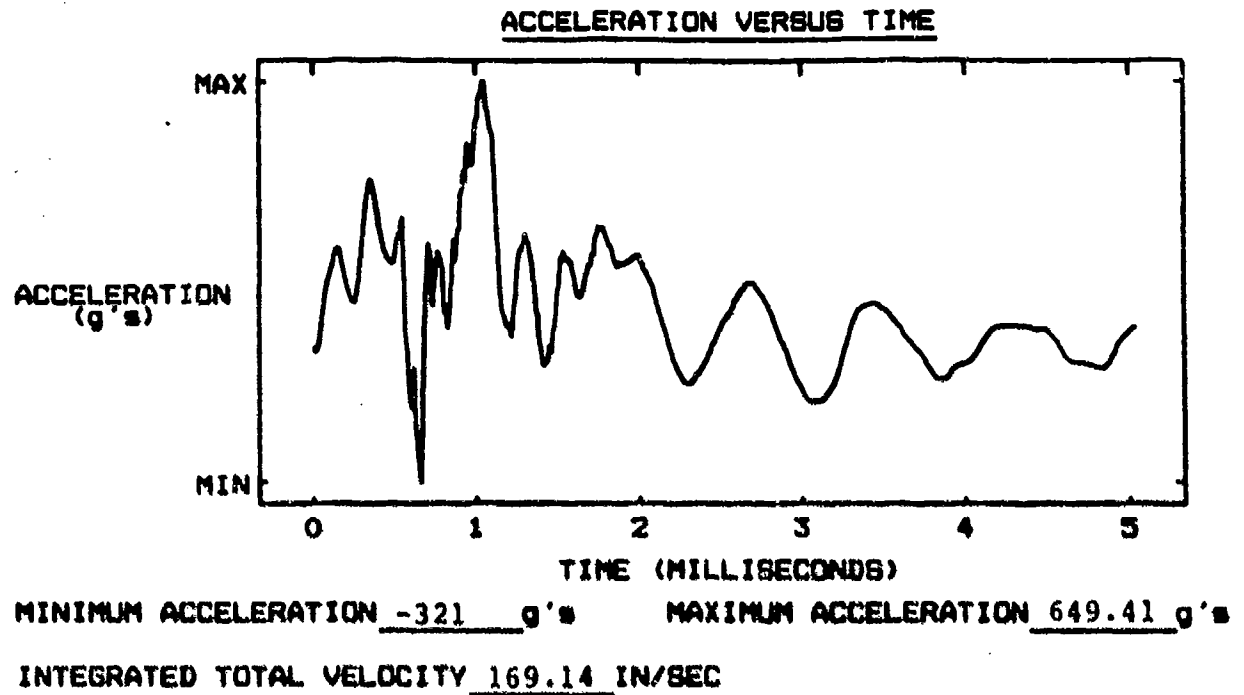


Figure B-55. Panel 2-11-6 Impact Response Data

# CSA1 - IM6/F650

PANEL 2-11-6 (ETW)

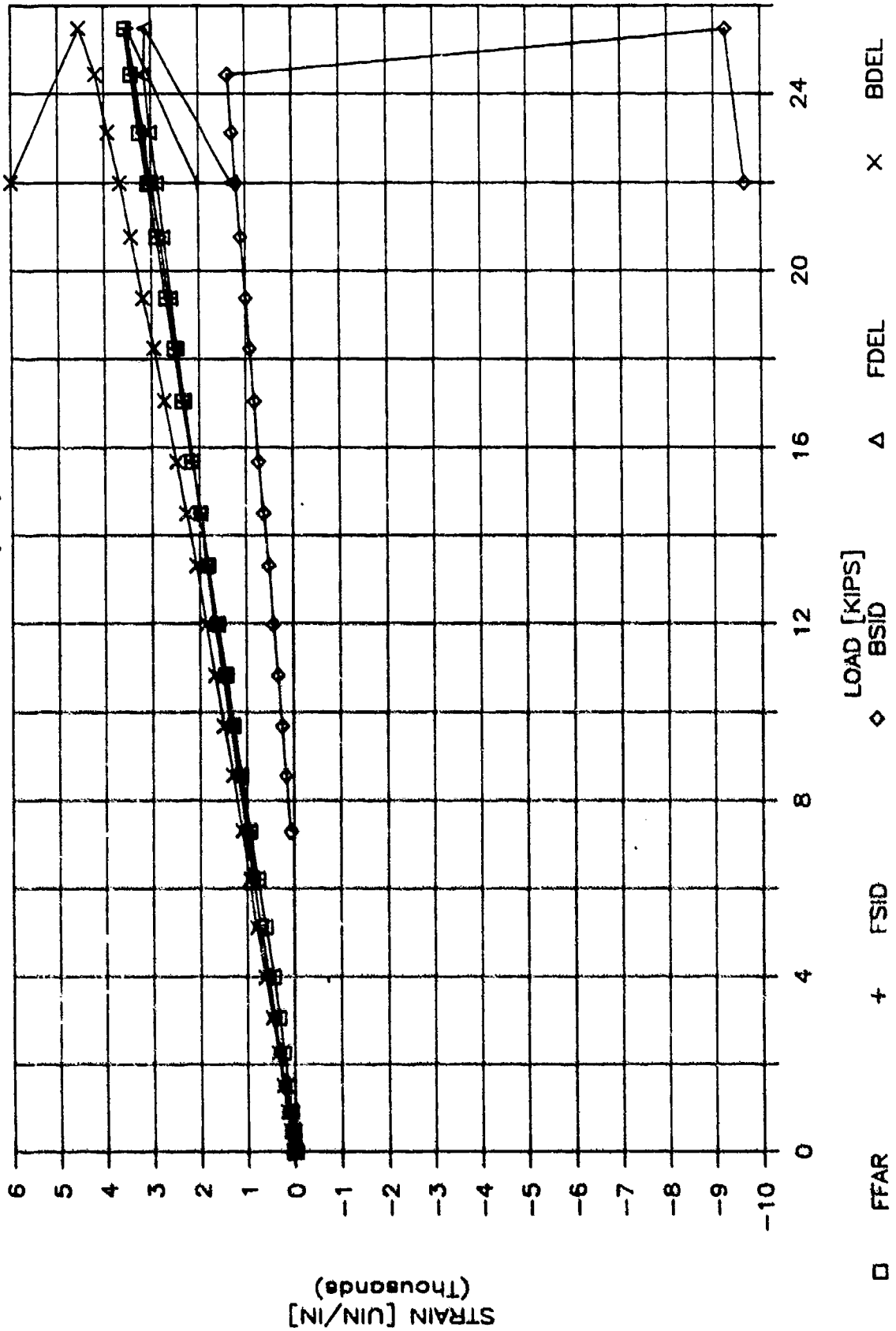


Figure B-58. Panel 2-11-6 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

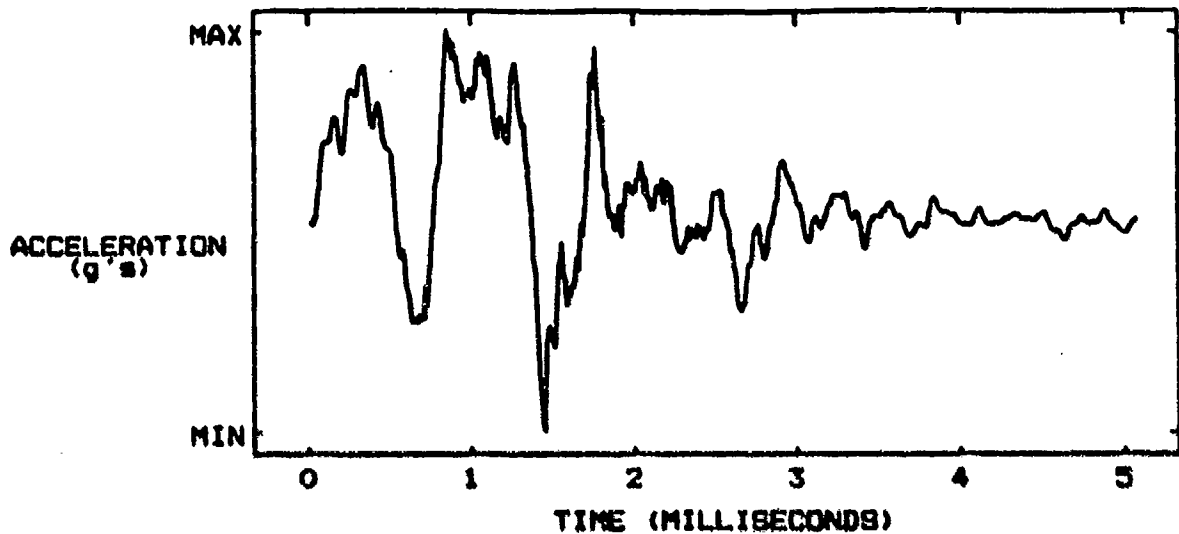
SPECIMEN I.D. 2-13-5

THICKNESS .436 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 24.5 IN

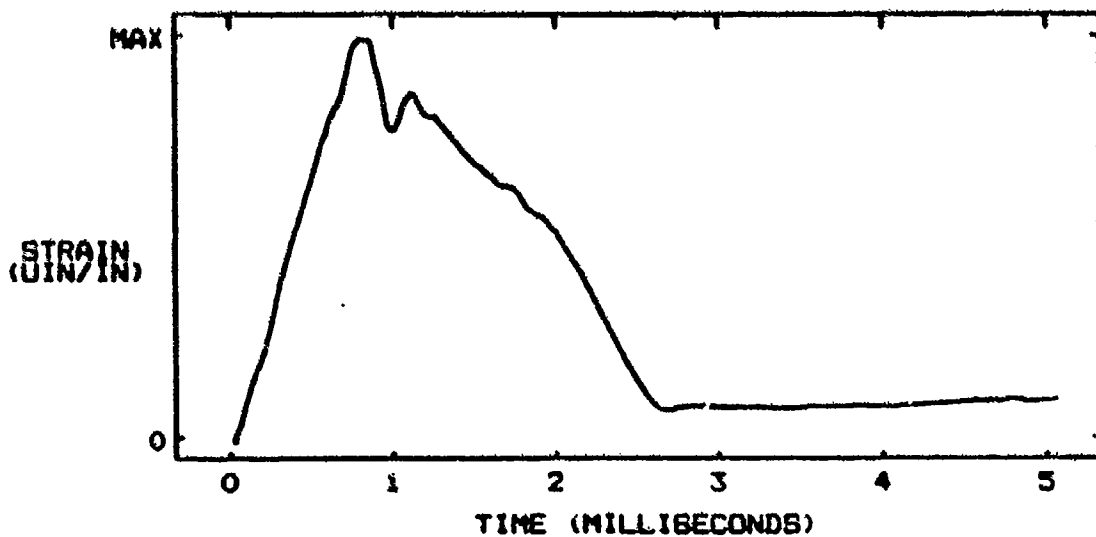
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -857 g's      MAXIMUM ACCELERATION 790 g's

INTEGRATED TOTAL VELOCITY 146.83 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 7571 UIN/IN

Figure B-57. Panel 2-13-5 Impact Response Data

# CSAI — IM6/F650

PANEL 2-13-5 (ETW)

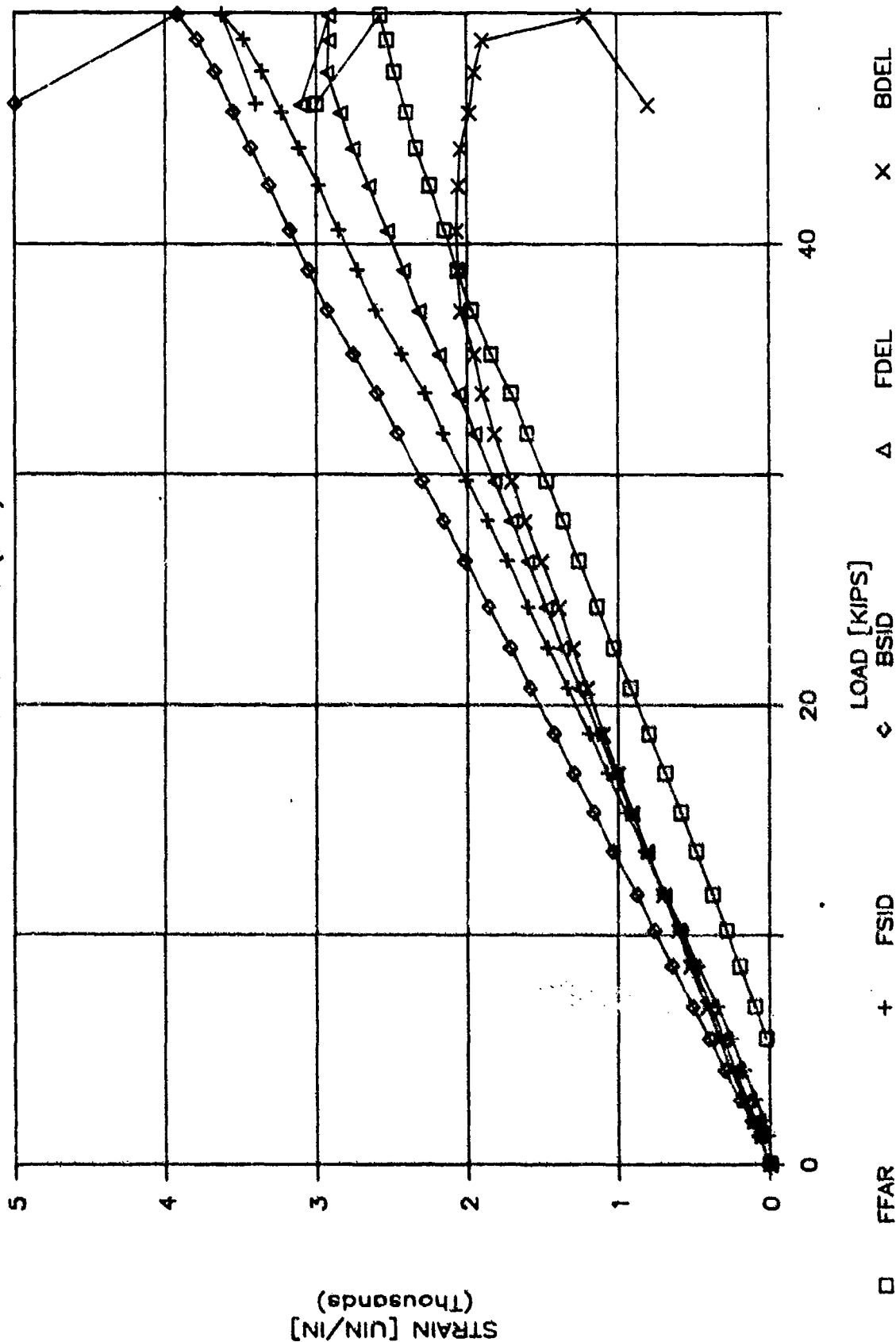


Figure B-58. Panel 2-13-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

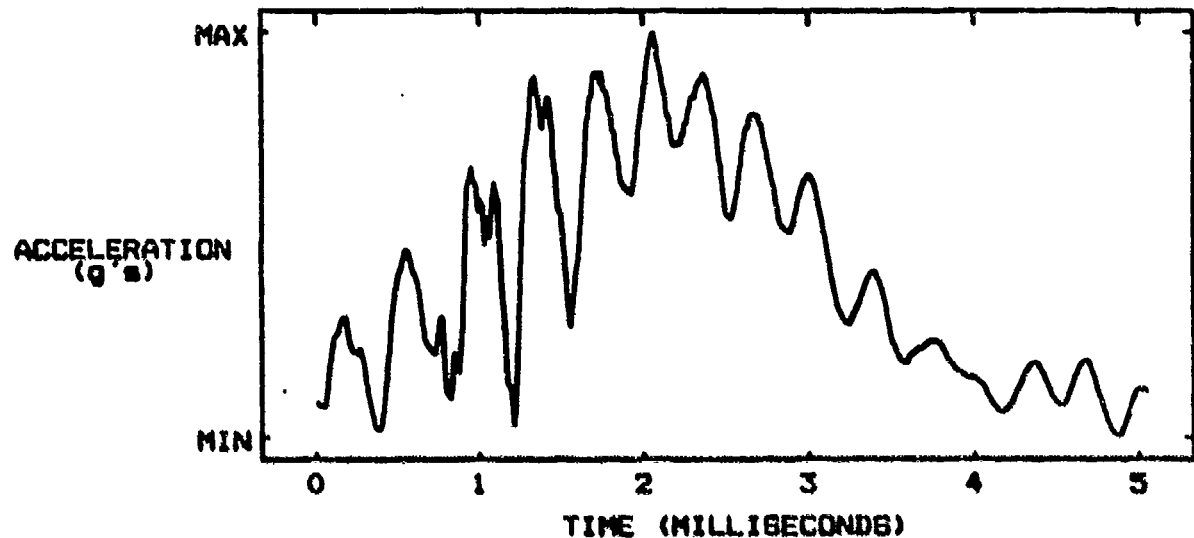
SPECIMEN I.D. 2-14-5

THICKNESS 1.11 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 23.3 IN

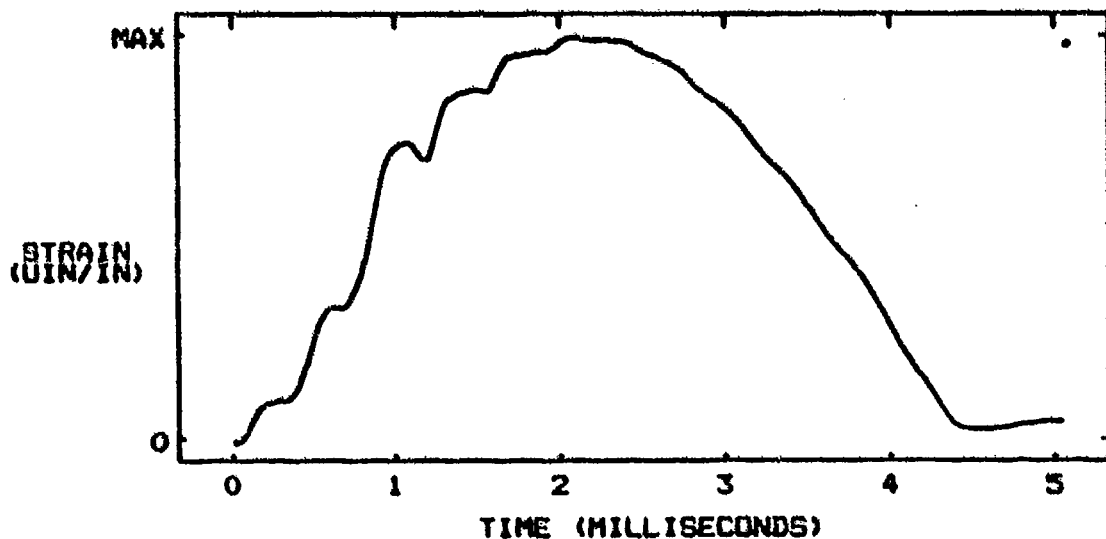
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -27 g's      MAXIMUM ACCELERATION 298.7 g's

INTEGRATED TOTAL VELOCITY 198.36 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 13156 UIN/IN

Figure B-59. Panel 2-14-5 Impact Response Data

# CSAI - IM6/F650

PANEL 2-14-5 (ETW)

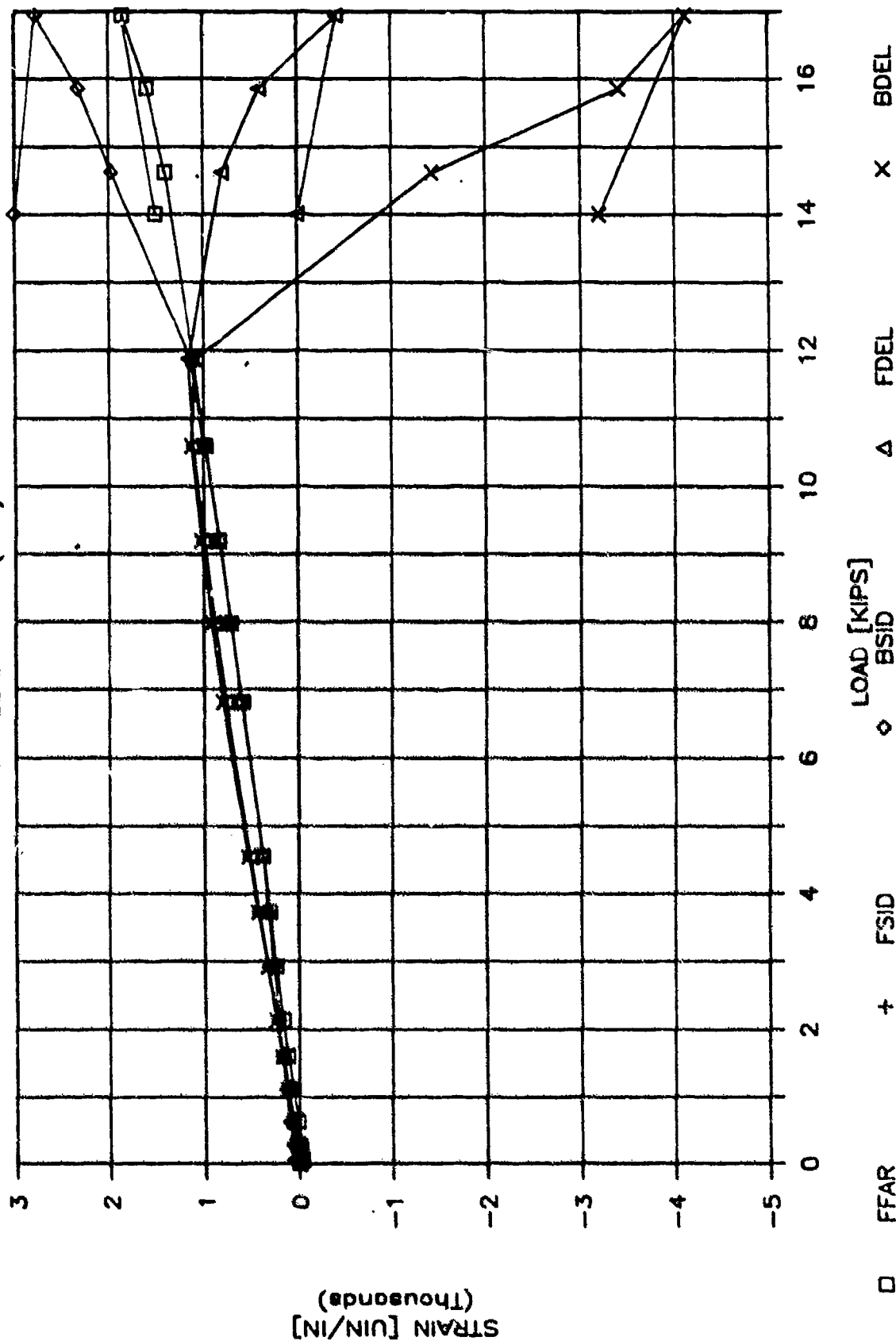


Figure B-80. Panel 2-14-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

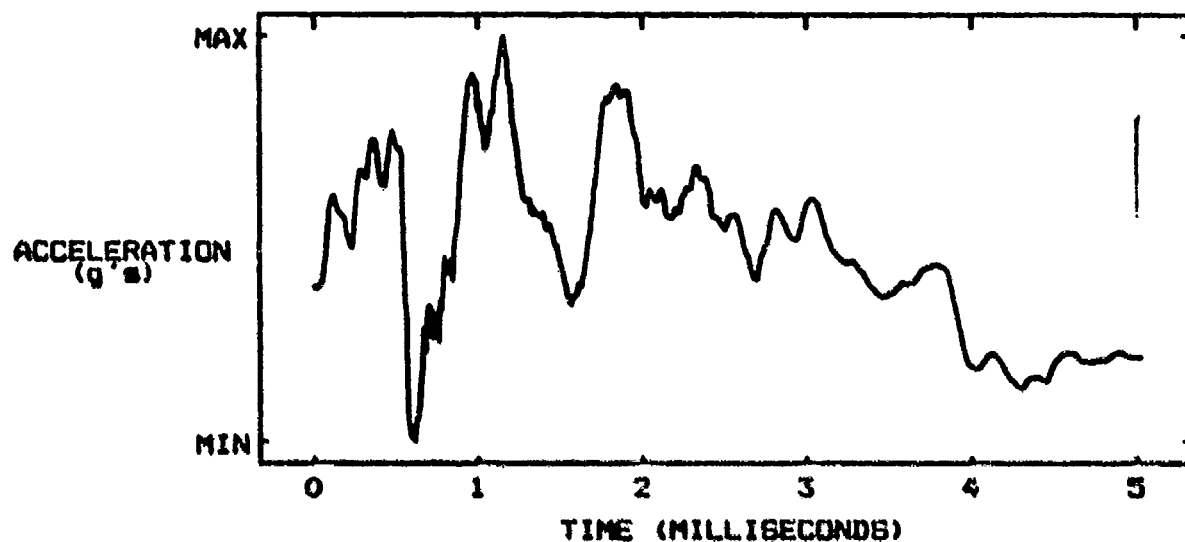
SPECIMEN I.D. 2-20-4

THICKNESS .219 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 16.3 IN

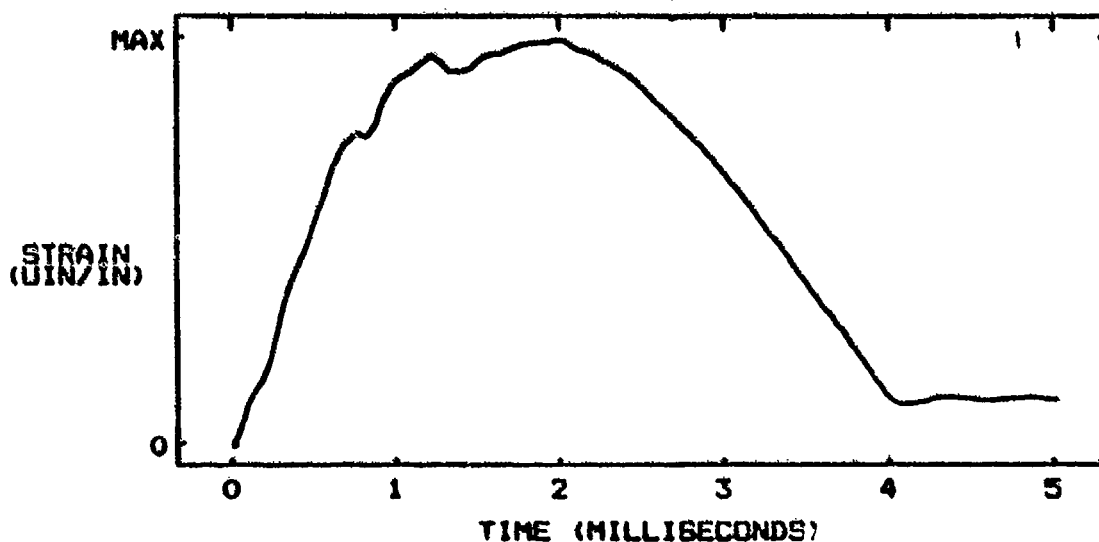
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -228 g's      MAXIMUM ACCELERATION 375 g's

INTEGRATED TOTAL VELOCITY 150.2 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 5912 UIN/IN

Figure B-61. Panel 2-20-4 Impact Response Data

# CSAI - IM6/F650

PANEL 2-20-4 (ETW)

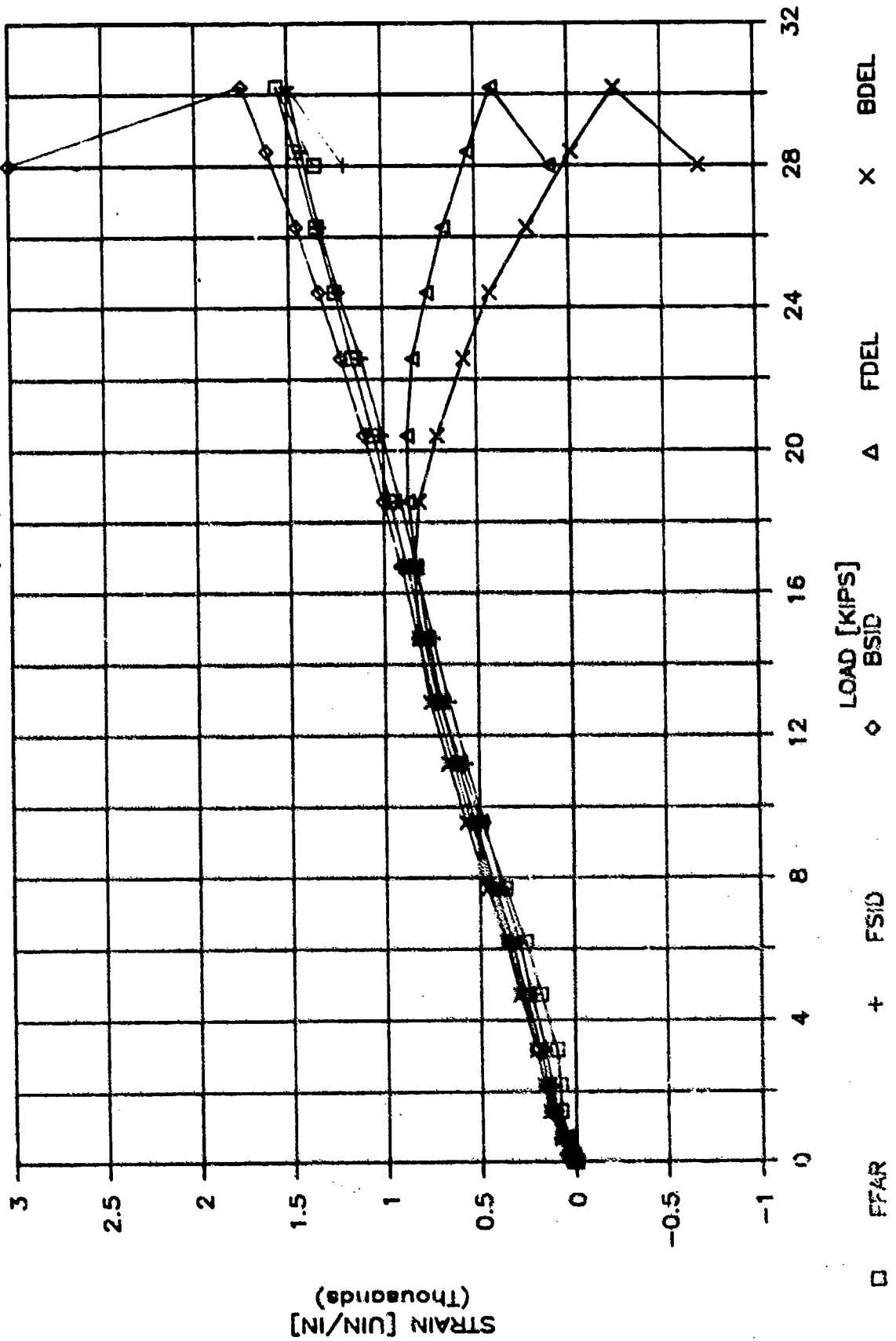


Figure B-62. Panel 2-20-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

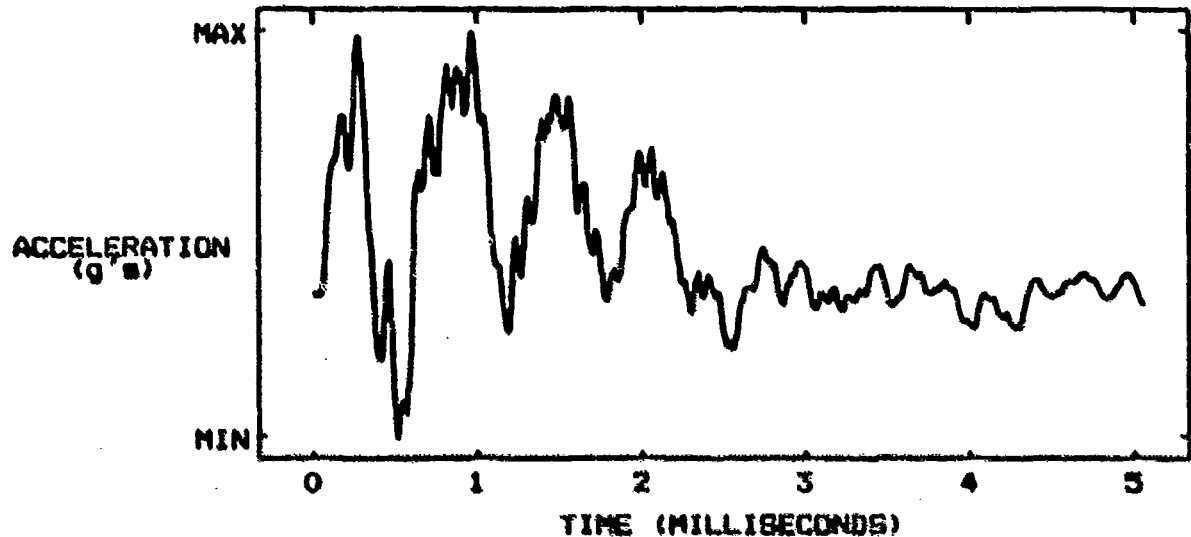
SPECIMEN I.D. 2-15-4

THICKNESS .441 IN

DROP CARRIAGE WT. 7.82 LBS

DROP HEIGHT 66.1 IN

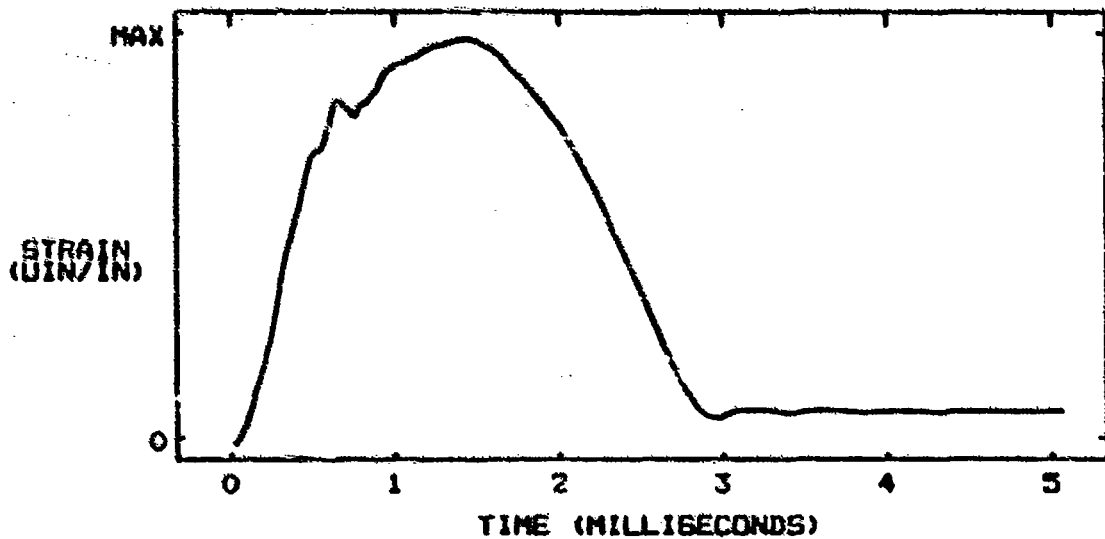
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -502 g's      MAXIMUM ACCELERATION 927 g's

INTEGRATED TOTAL VELOCITY 281.65 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9708 UIN/IN

Figure B-63. Panel 2-15-4 Impact Response Data

# CSAI - IM6/F650

PANEL 2-15-4 (ETW)

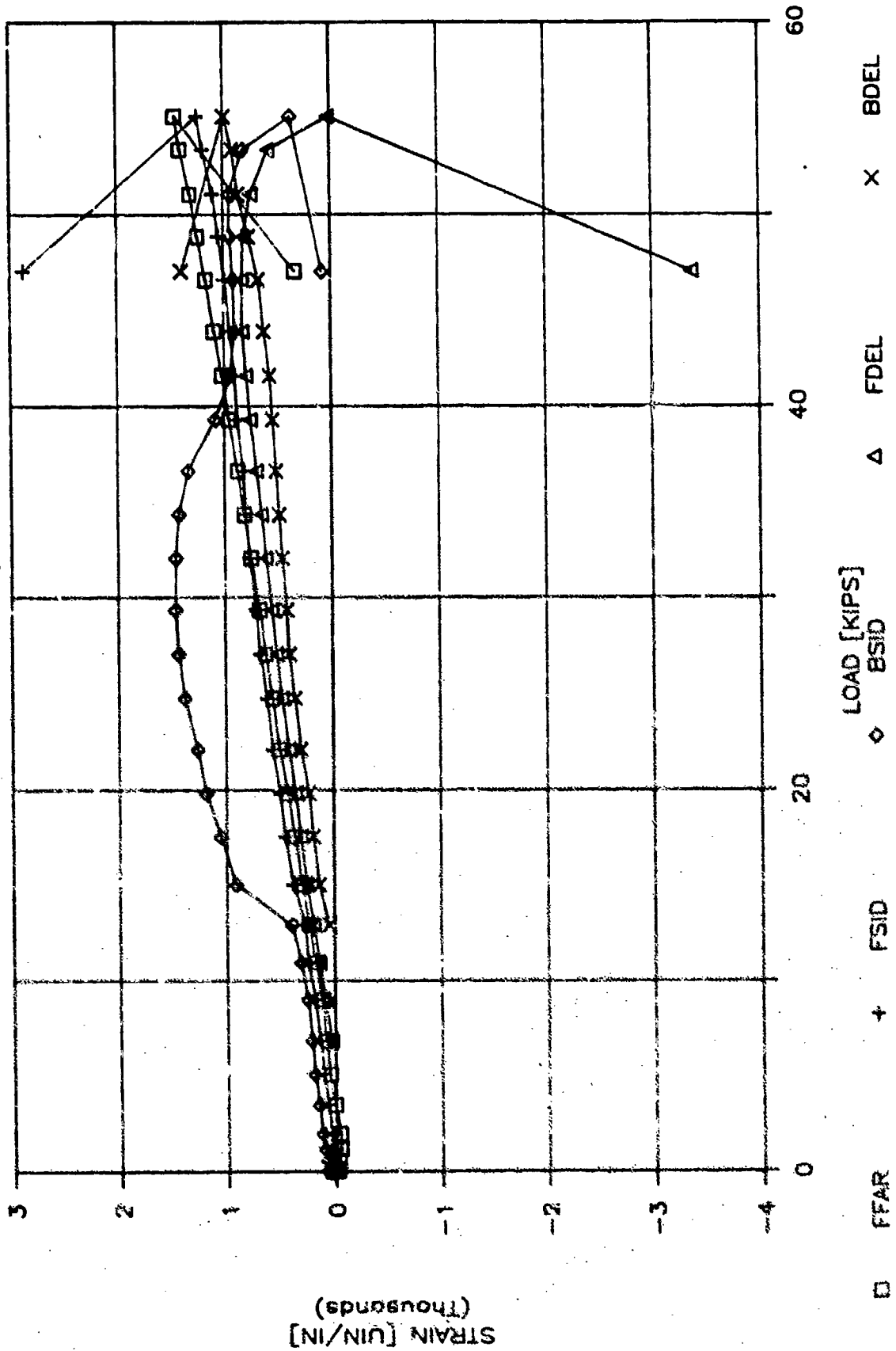


Figure B-64. Panel 2-15-4 Residual Compression Data

B.2 THIN LAMINATE IMPACT DAMAGE

Material	Specimen Number	Layup	Thickness (in.)	Impact Weight (lb)	Nominal Impact Energy (ft-lb)	Potential Impact Energy (ft-lb)	Kinetic Impact Energy (ft-lb)	G <sub>max</sub>	ε <sub>max</sub> (μin./in.)	Dent Depth (in.)	Delamination Width (in.)	Residual Strength (ksi)	Residual Strain (μin./in.)
RTD													
IM6/3100	1-16-2	0/100/0	0.024	3.83	5	5.33	5.26	111	1,420	0.001	0.2	11.5	1,800
	1-12A-1		0.045	3.83	5	5.33	—	149	780	0.004	0.4	17.0	4,500
	1-17-2		0.068	3.83	5	5.33	5.13	201	1,134	0.004	0.7	20.8	9,300
IM6/3100	1-18-1	50/0/50	0.025	3.83	5	5.33	5.17	108	1,725	0.025	0.6	15.5	2,150
	1-14A-1		0.046	3.83	5	5.33	5.17	160	1,400	0.004	0.5	23.4	2,500
	1-19-2		0.085	3.83	5	5.33	5.15	177	1,250	0.004	0.8	28.6	2,000
IM6/F650	2-16-1	0/100/0	0.022	3.83	5	5.33	5.22	128	280	0.011	1.0	9.1	—
	2-12A-1		0.044	3.83	5	5.33	5.20	137	1,090	0.005	0.6	13.7	6,000
	2-17-2		0.064	3.83	5	5.33	—	177	500	0.005	0.9	16.5	5,800
IM6/F650	2-18-2	50/0/50	0.023	3.83	5	5.33	5.20	75	1,330	<0.001	0.5	11.0	1,700
	2-14A-1		0.043	3.83	5	5.33	5.15	157	1,120	0.005	0.9	20.3	1,300
	2-19-2		0.084	3.83	5	5.33	5.17	166	1,020	0.005	1.1	19.2	1,450
ETW													
IM6/3100	1-16-4	0/100/0	0.024	3.83	5	5.33	5.24	114	630	<0.001	—	8.9	1,300
	1-12A-5		0.045	3.83	5	5.33	5.26	151	820	0.004	—	12.5	12,500
	1-17-5		0.069	3.83	5	5.33	5.17	198	1,180	0.004	—	12.1	18,000
IM6/3100	1-18-6	50/0/50	0.025	3.83	5	5.33	5.20	108	1,440	0.002	—	19.6	1,250
	1-14A-4		0.046	3.83	5	5.33	5.17	160	1,520	0.004	—	27.2	2,100
	1-19-5		0.065	3.83	5	5.33	5.22	147	1,040	0.004	—	18.7	2,400
IM6/F650	2-16-5	0/100/0	0.022	3.83	5	5.33	—	98	314	0.001	—	6.1	700
	2-12A-4		0.043	3.83	5	5.33	5.26	140	792	0.004	—	9.3	10,500
	2-17-6		0.064	3.83	5	5.33	5.17	169	1,070	0.005	—	9.7	8,600
IM6/F650	2-18-5	50/0/50	0.022	3.83	5	5.33	5.20	88	1,440	0.015	—	11.7	650
	2-14A-5		0.044	3.83	5	5.33	5.15	149	1,160	0.004	—	20.0	2,100
	2-19-6		0.062	3.83	5	5.33	5.17	148	1,110	0.004	—	16.6	1,300

QP63-0000-07

Figure B-65. Thin Laminate Impact Damage Data Table

## LVLD SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

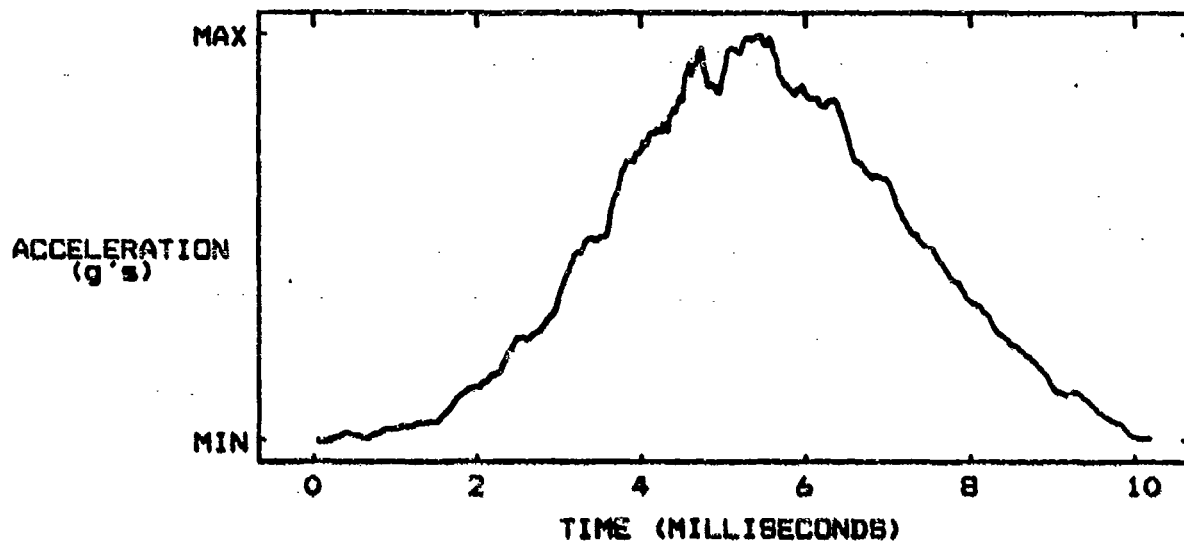
SPECIMEN I.D. 1-16-2.1

THICKNESS .024 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

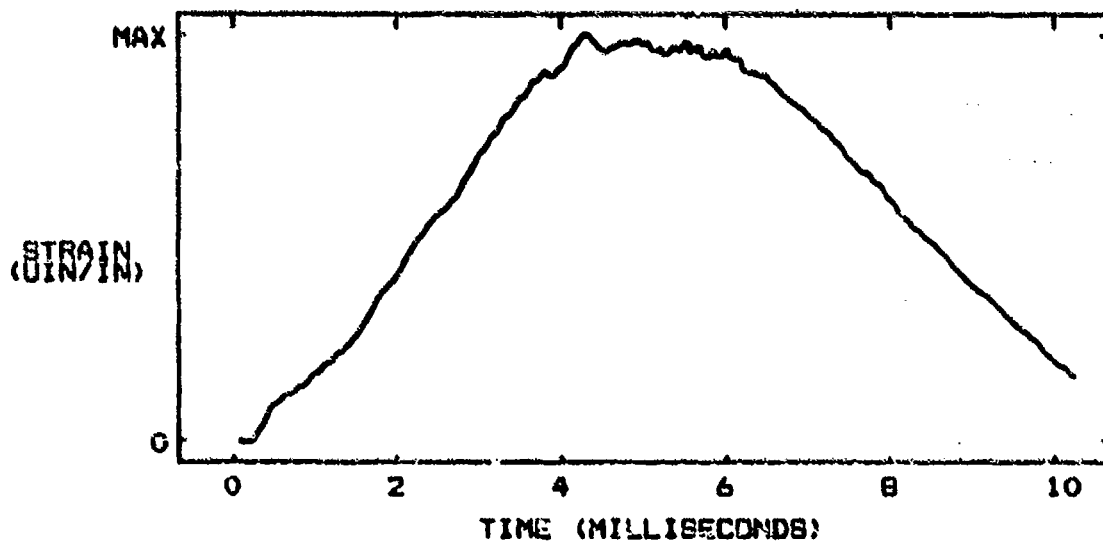
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION 0.0 g's      MAXIMUM ACCELERATION 111 g's

INTEGRATED TOTAL VELOCITY 175.96 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1415 μIN/IN

Figure B-66. Panel 1-16-2 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

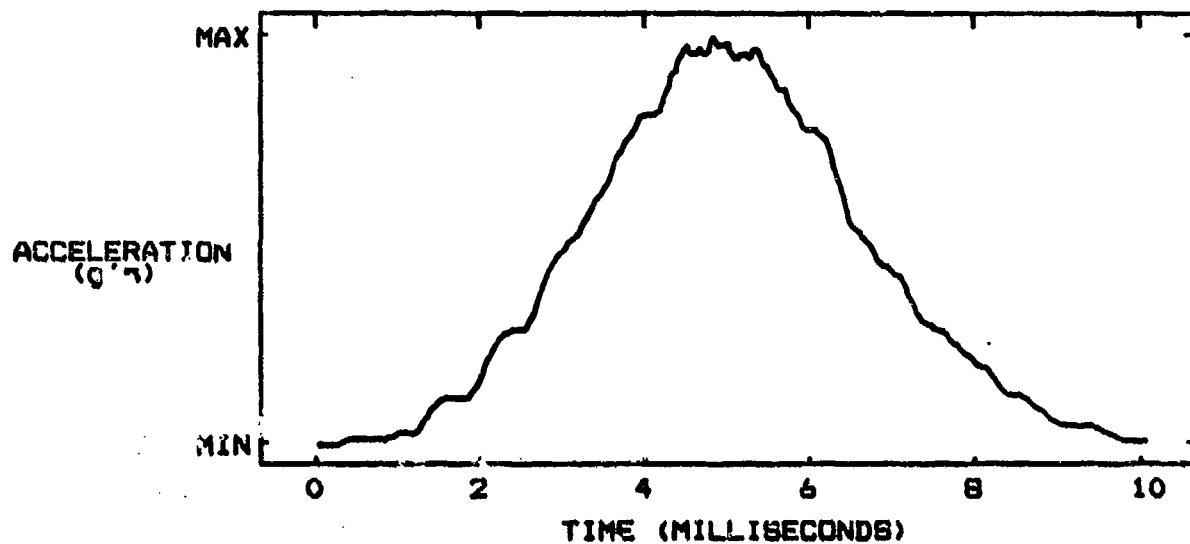
SPECIMEN I.D. 1-16-2.2

THICKNESS .024 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

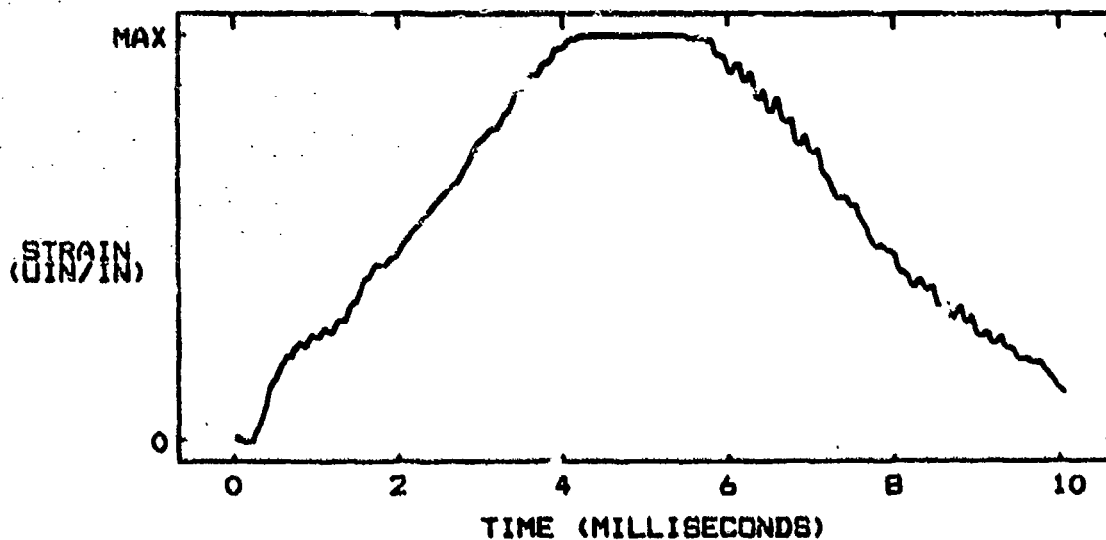
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION 0.0 g's      MAXIMUM ACCELERATION 119 g's

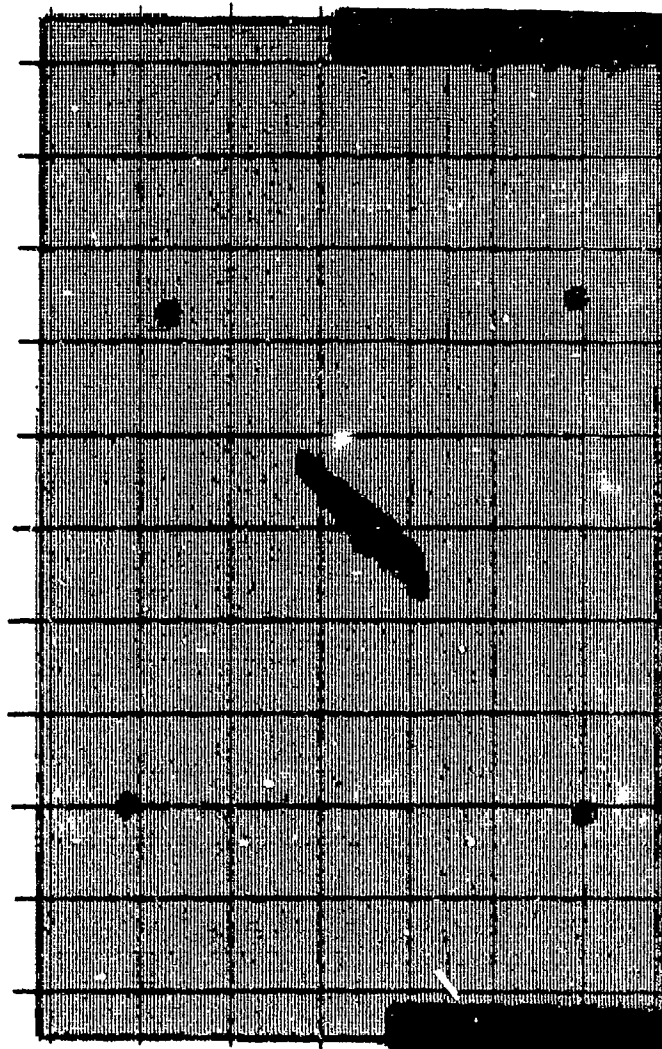
INTEGRATED TOTAL VELOCITY 177.92 IN/SFC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 615.6 UIN/IN

Figure B-67. Panel 1-16-2 Second Impact Response Data



**Specimen 1-16-2**

**Figure B-68. Panel 1-16-2 C-Scan**

# CSAI - IM6/3100

PANEL 1-16-2 (RTD)

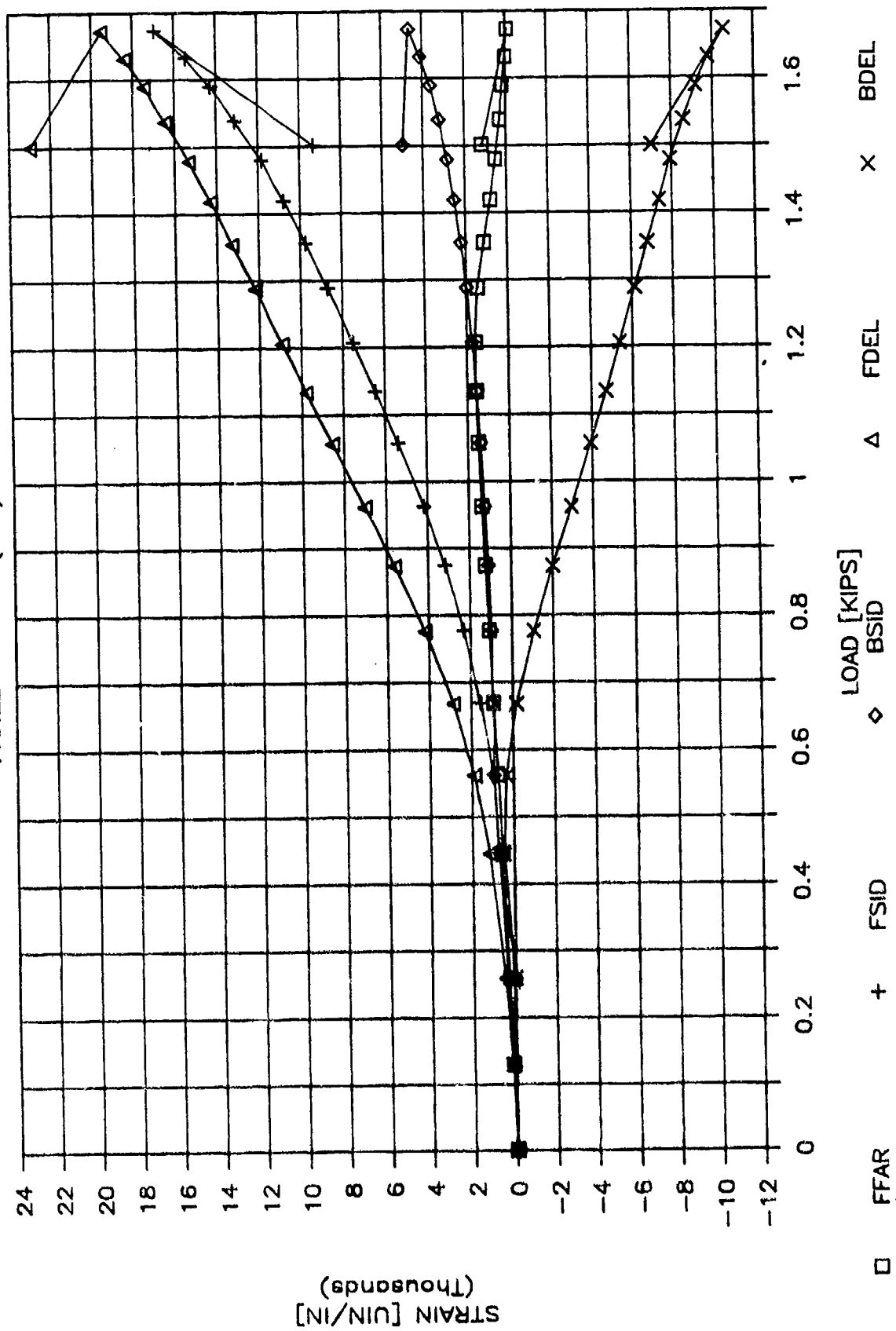


Figure B-69. Panel 1-16-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

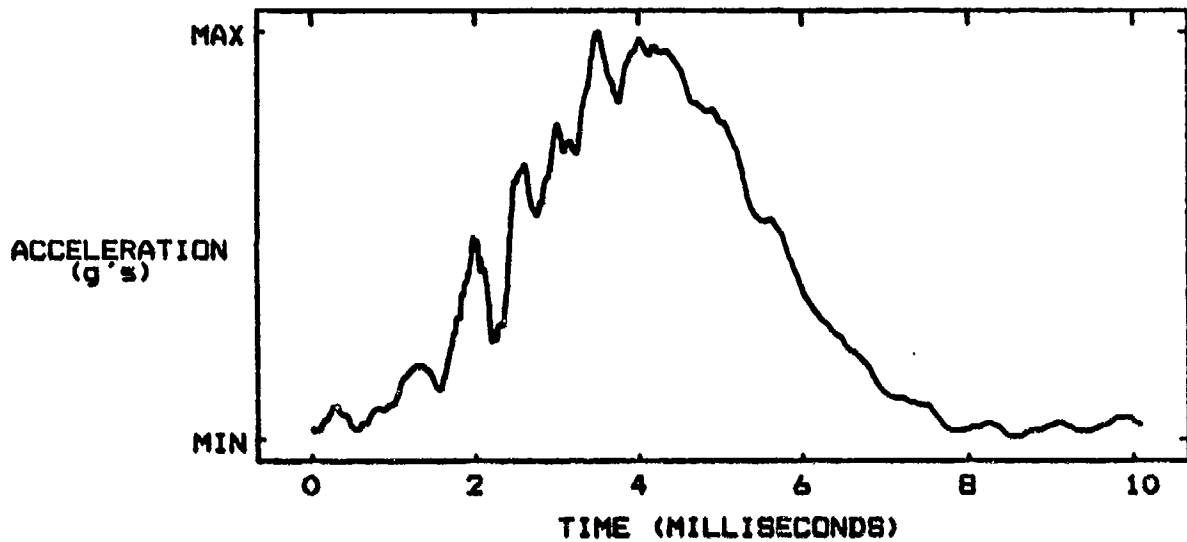
SPECIMEN I.D. 1-12A-1.1

THICKNESS .045 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

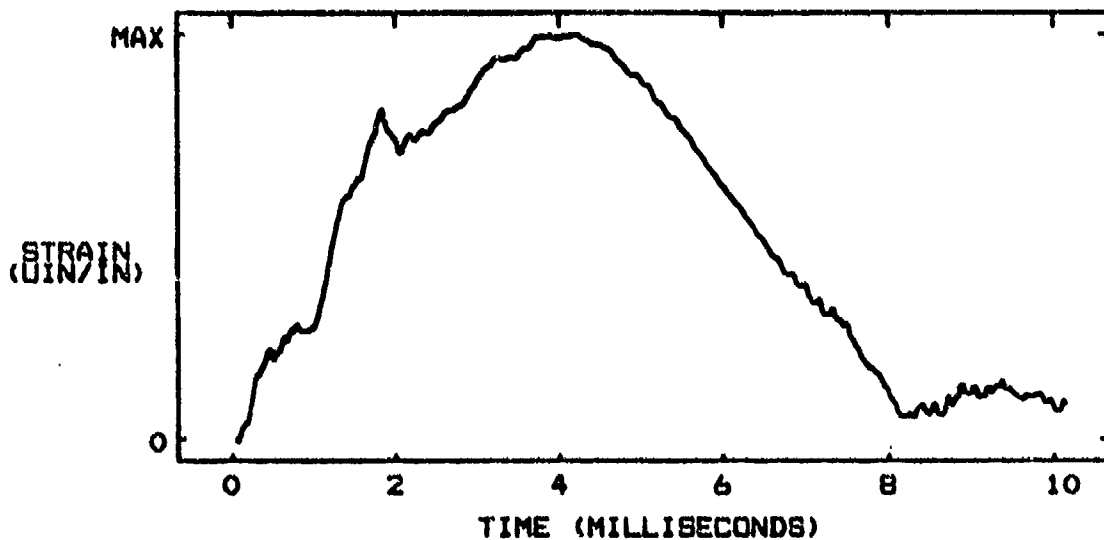
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -3.0 g's      MAXIMUM ACCELERATION 149 g's

INTEGRATED TOTAL VELOCITY 186.68 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 782  $\mu$ IN/IN

Figure B-70. Panel 1-12A-1 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

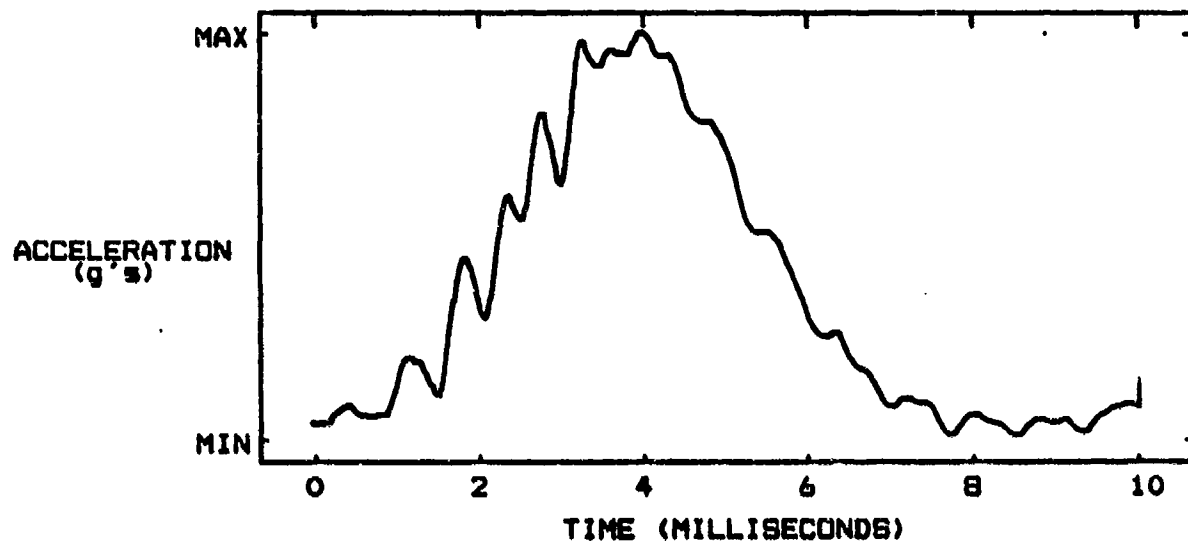
SPECIMEN I.D. 1-12A-1.2

THICKNESS .044 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

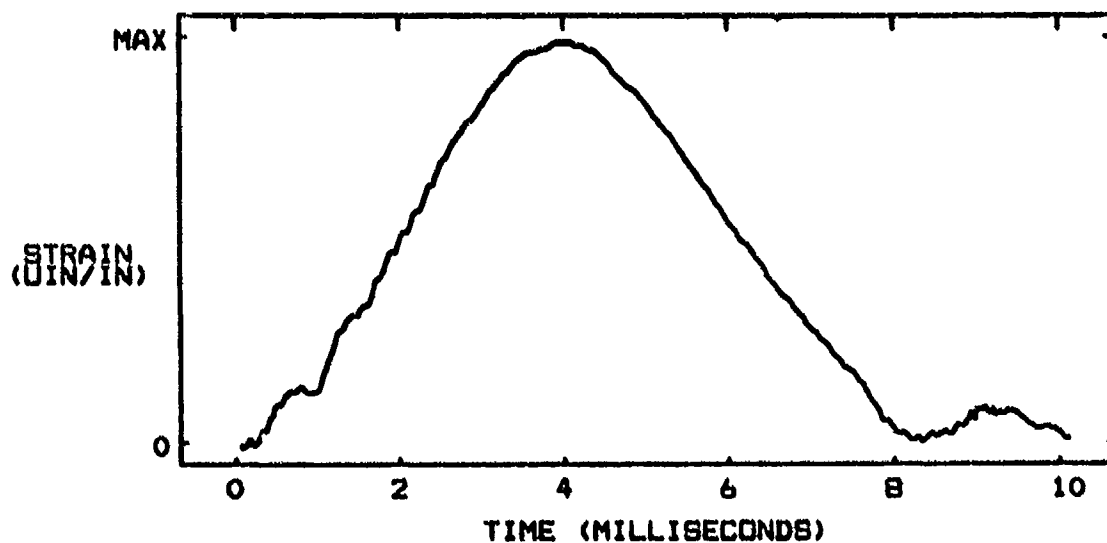
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -6.0 g's      MAXIMUM ACCELERATION 153 g's

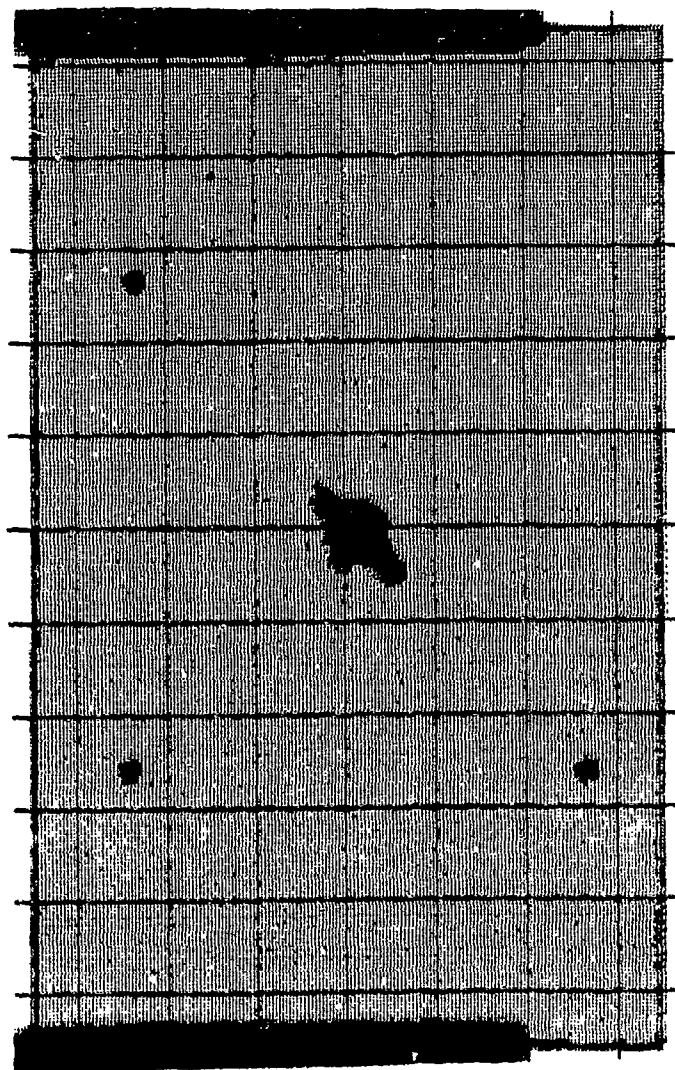
INTEGRATED TOTAL VELOCITY 187.28 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1121 UIN/IN

Figure B-71. Panel 1-12A-1 Second Impact Response Data



Specimen 1-12A-1

Figure B-72. Panel 1-12A-1 C-Scan

# CSAI — IM6/3100

PANEL 1-12A-1 (RTD)

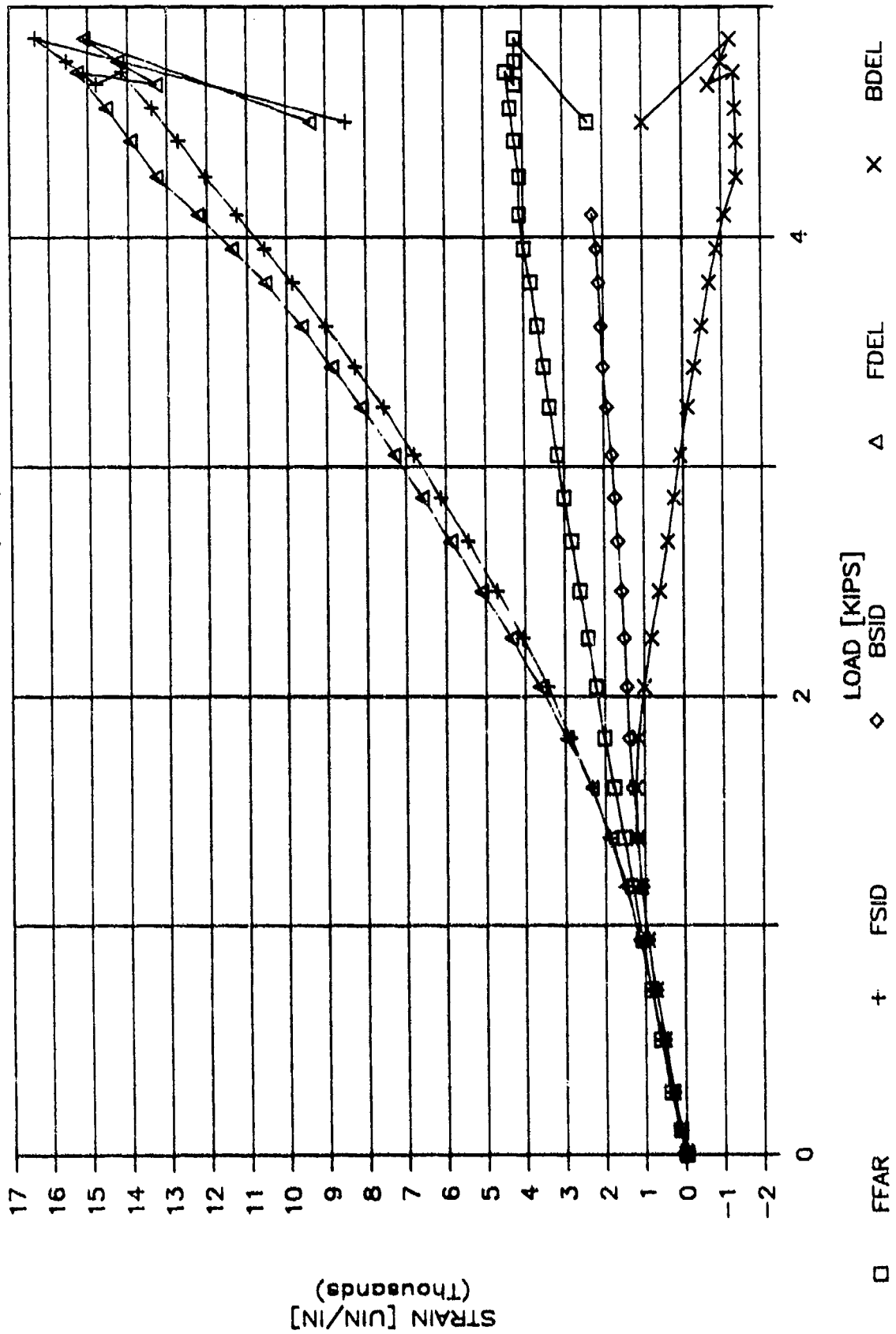


Figure B-73. Panel 1-12A-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

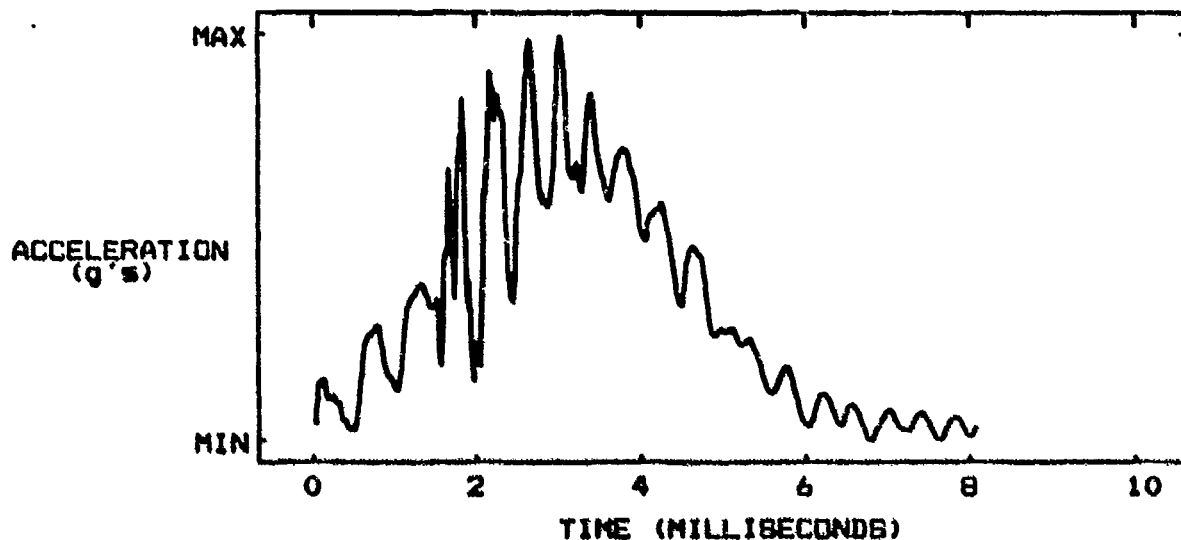
SPECIMEN I.D. 1-17-2

THICKNESS .068 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

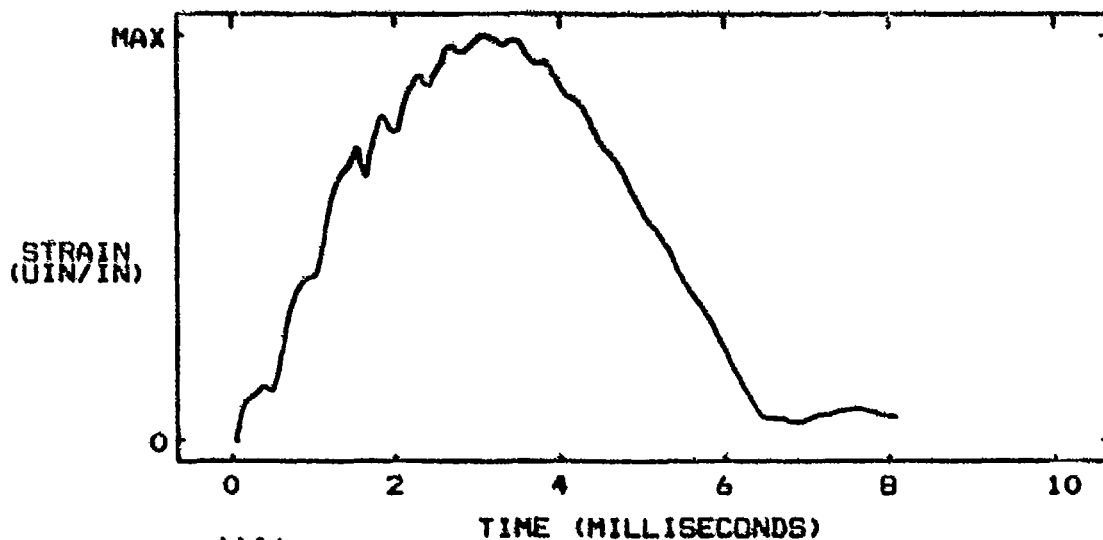
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -10.0 g's      MAXIMUM ACCELERATION 201 g's

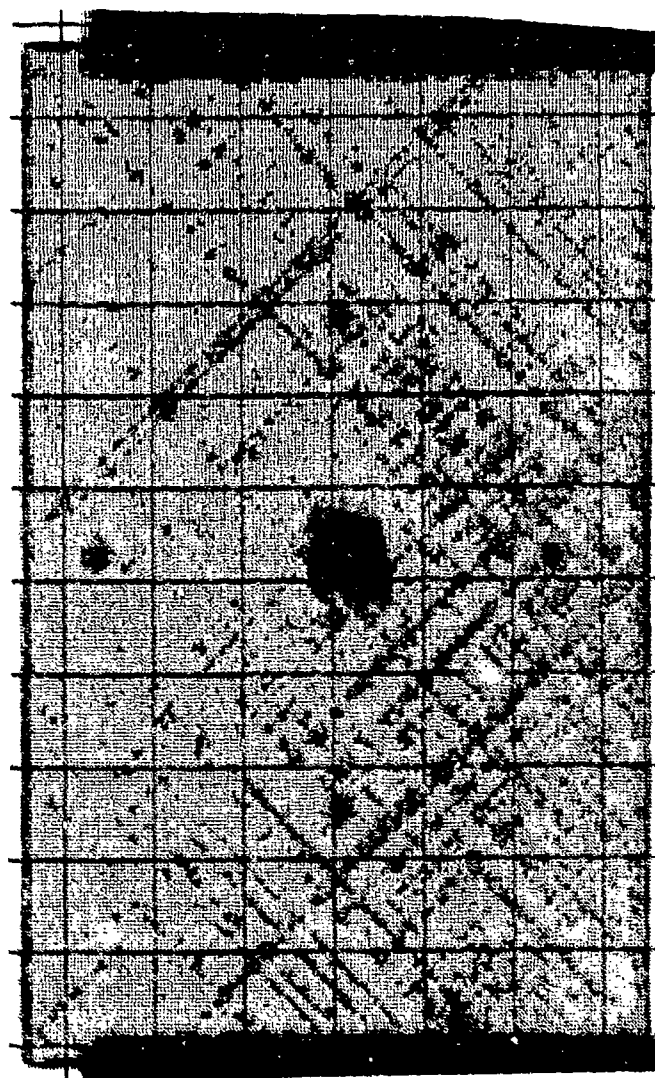
INTEGRATED TOTAL VELOCITY 179.38 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1134 UIN/IN

Figure 5-74. Panel 1-17-2 Impact Response Data



Specimen 1-17-2

Figure B-75. Panel 1-17-2 C-Scan

# CSAI - IM6/3100

PANEL 1-17-2 (RTD)

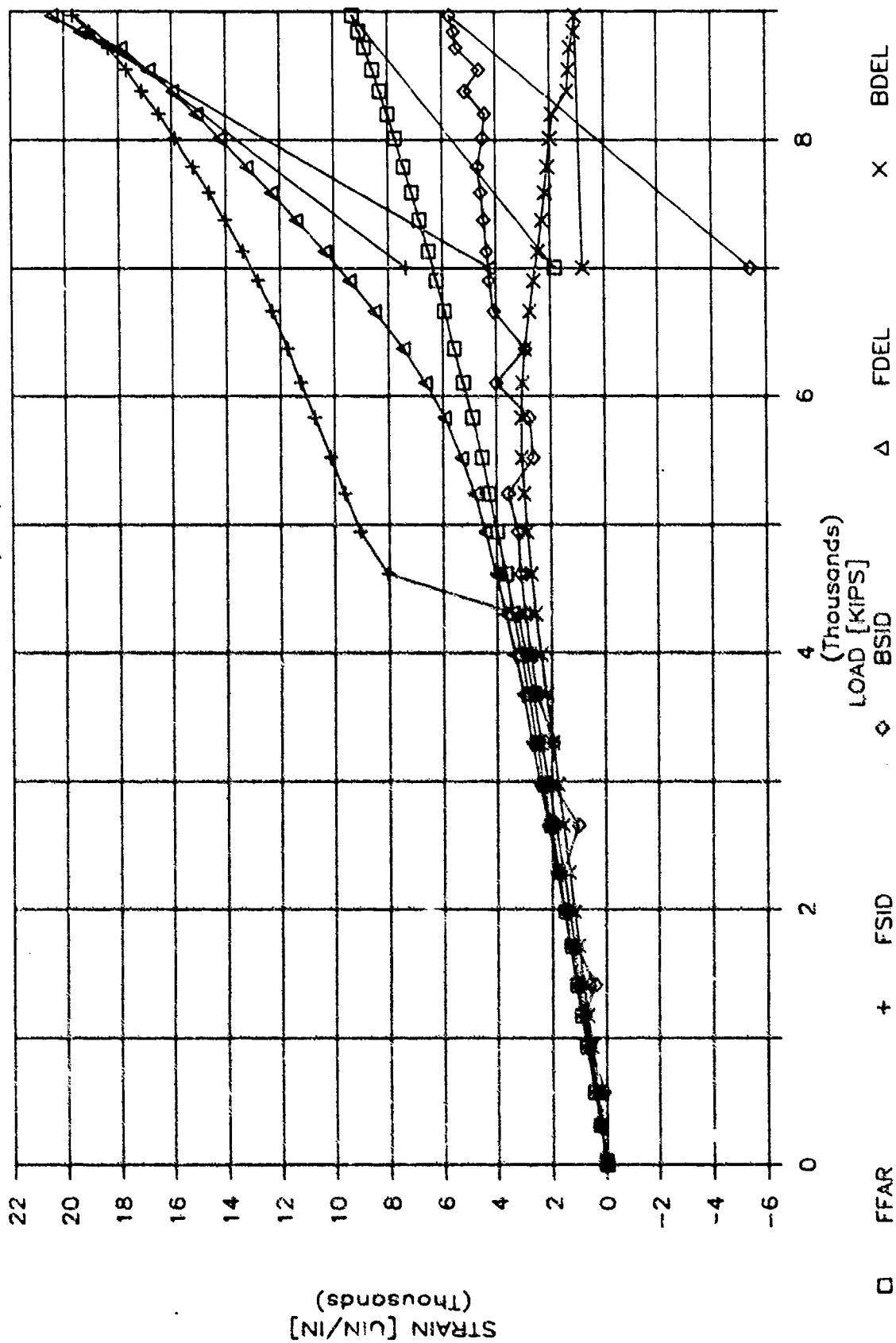


Figure 8-76. Panel 1-17-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

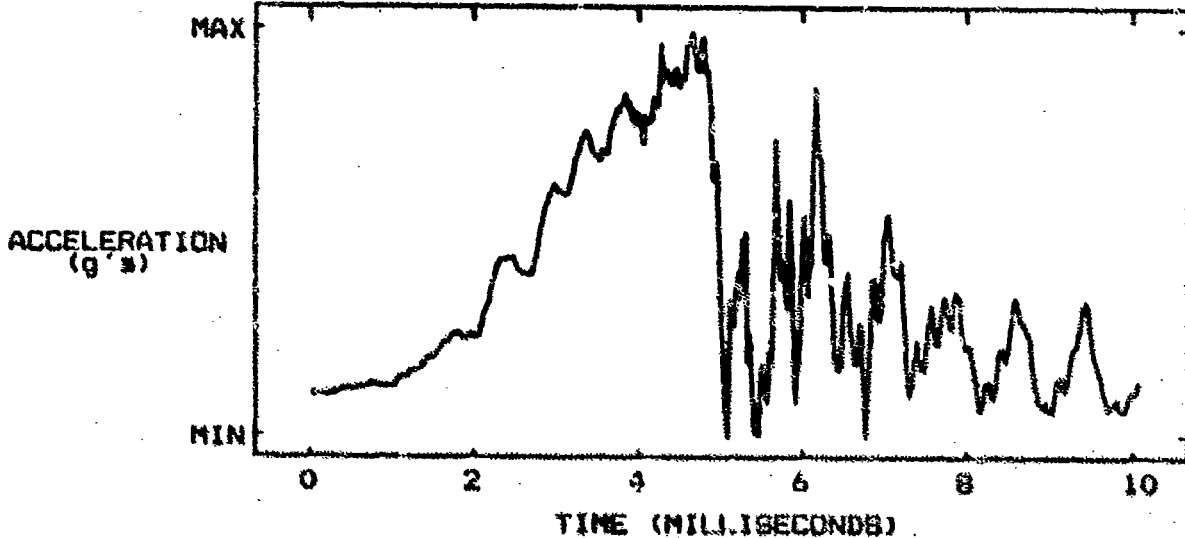
SPECIMEN I.D. 1-18-1

THICKNESS .025 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

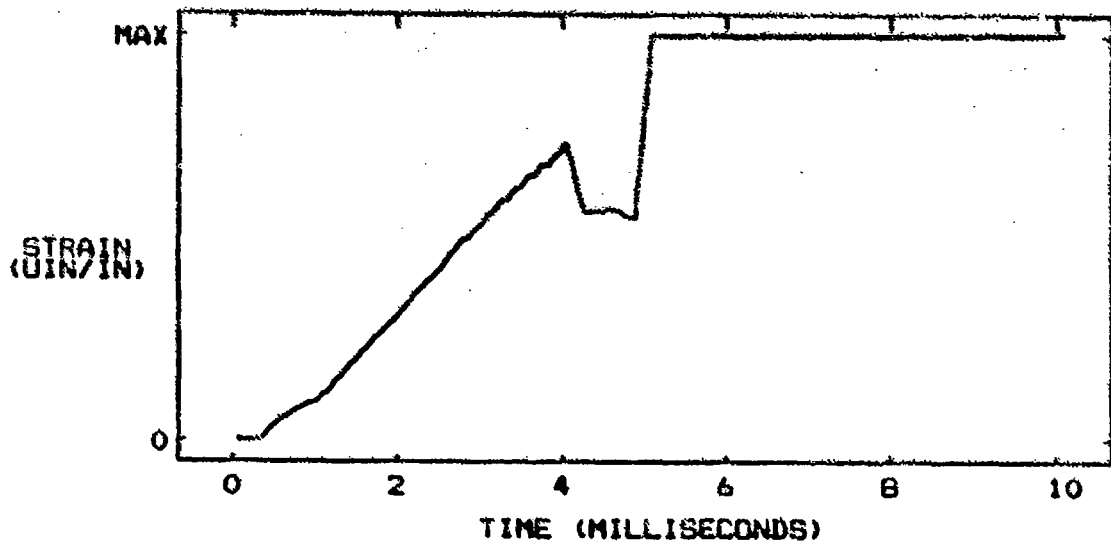
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -13.0 g's      MAXIMUM ACCELERATION 109 g's

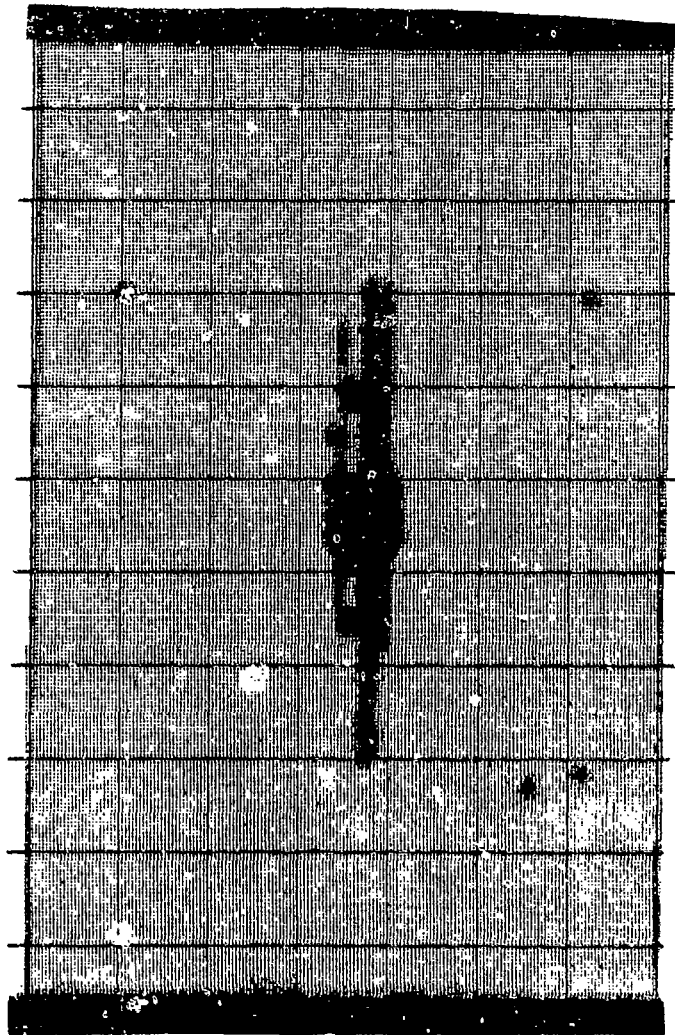
INTEGRATED TOTAL VELOCITY 118.21 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1725 UIN/IN

Figure B-77. Panel 1-18-1 Impact Response Data



**Specimen 1-18-1**

**Figure B-76. Panel 1-18-1 C-Scan**

# CSA1 - IM6/3100

PANEL 1-18-1 (RTD)

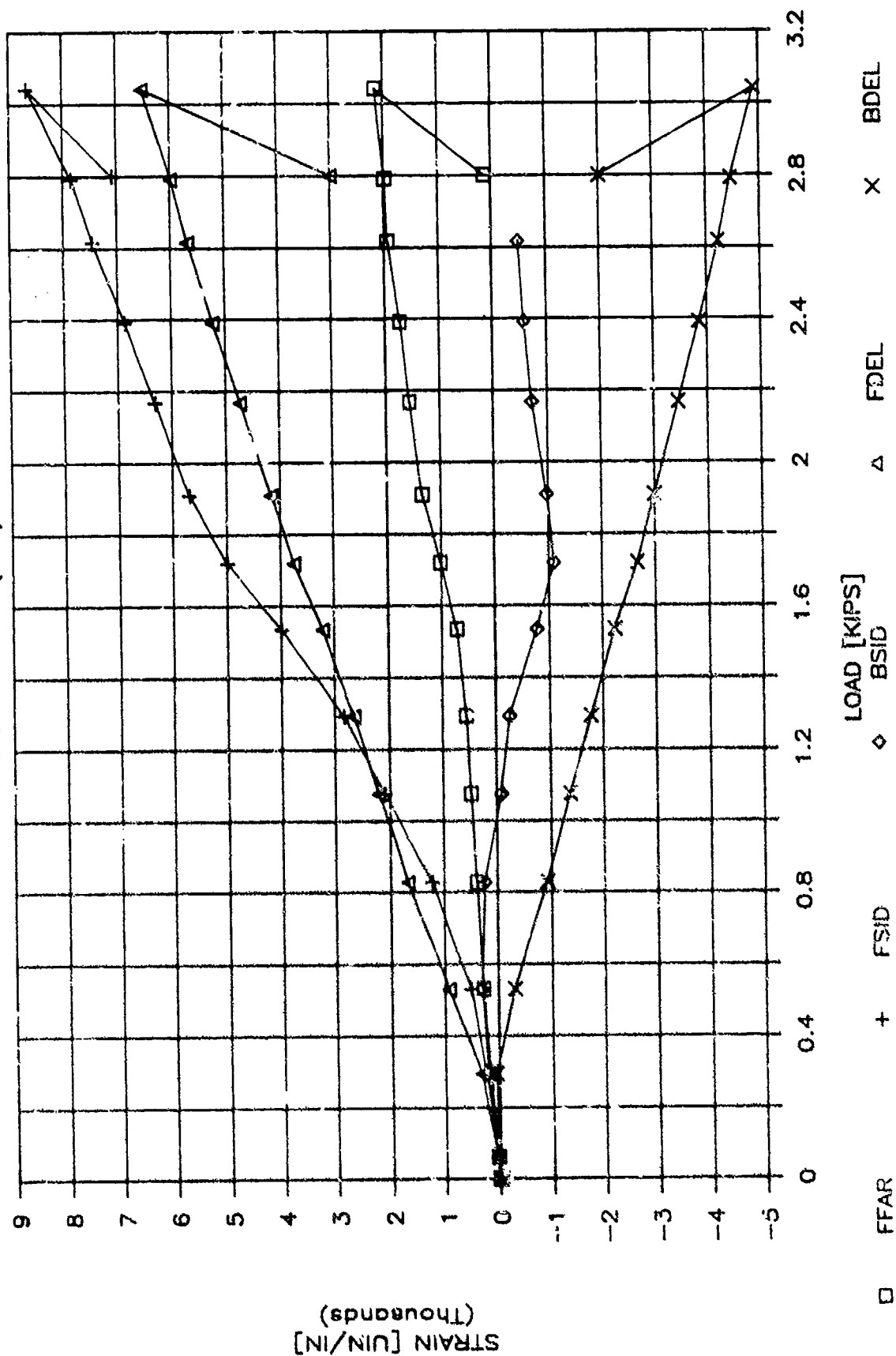


Figure 3-78. Panel 1-18-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

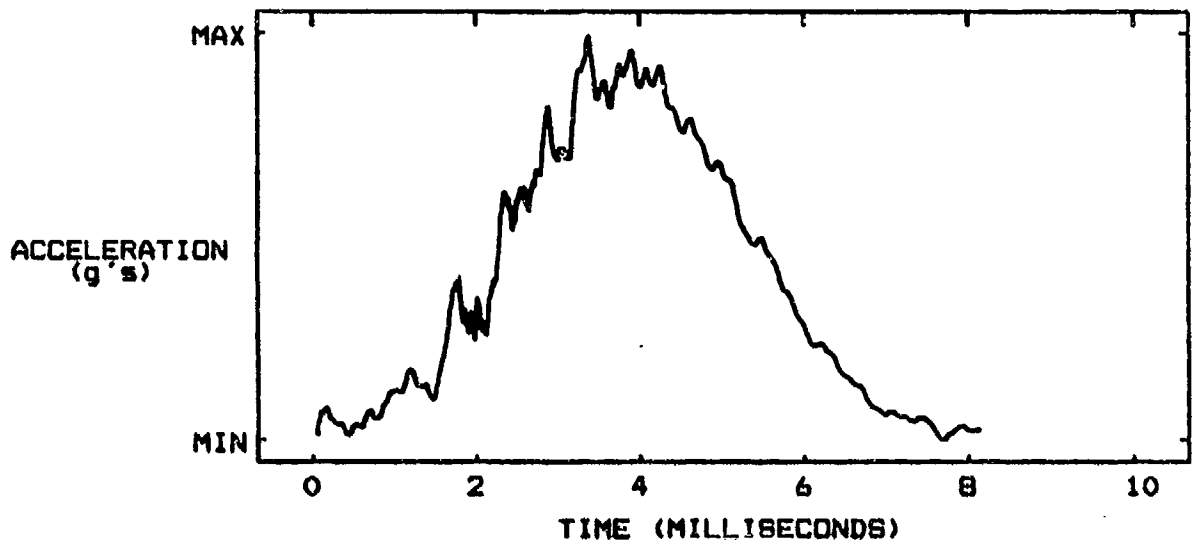
SPECIMEN I.D. 1-14A-1.1

THICKNESS .046 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

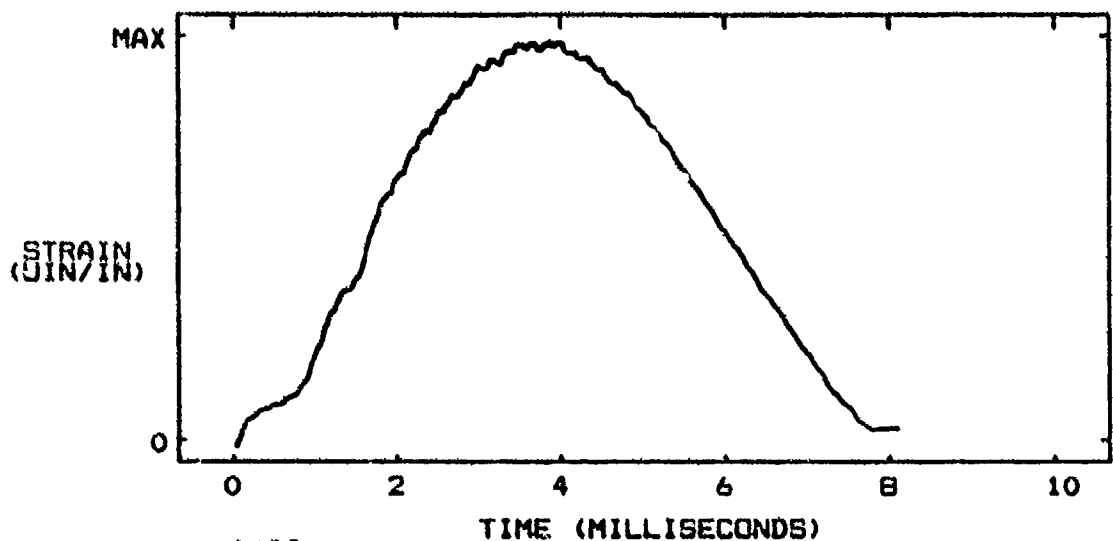
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -3.0 g's      MAXIMUM ACCELERATION 160 g's

INTEGRATED TOTAL VELOCITY 187.07 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1405  $\mu\text{IN}/\text{IN}$

Figure B-80. Panel 1-14A-1 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

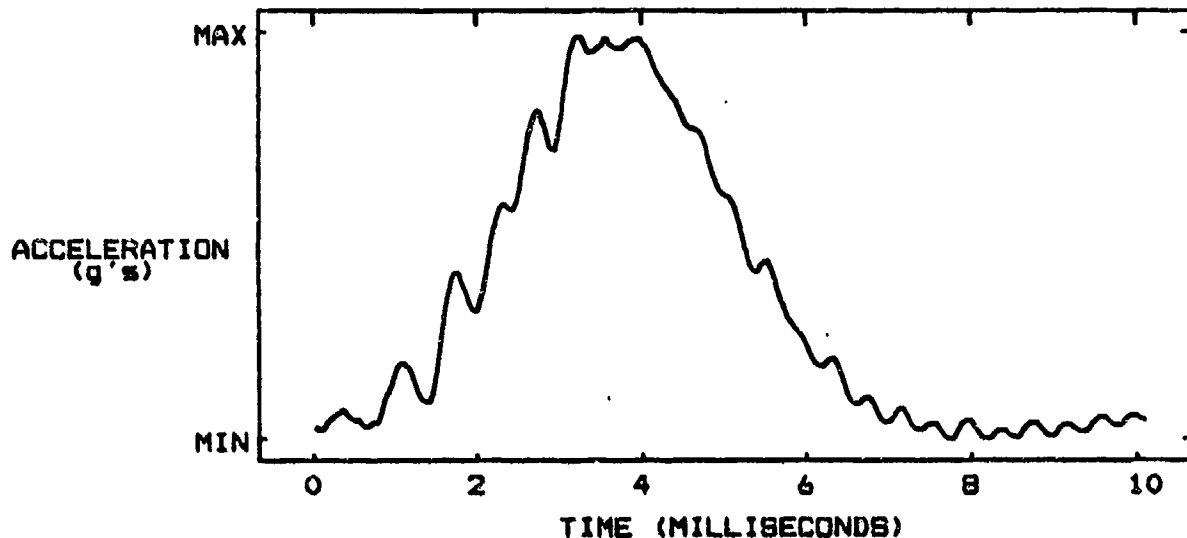
SPECIMEN I.D. 1-14A-1.2

THICKNESS .046 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

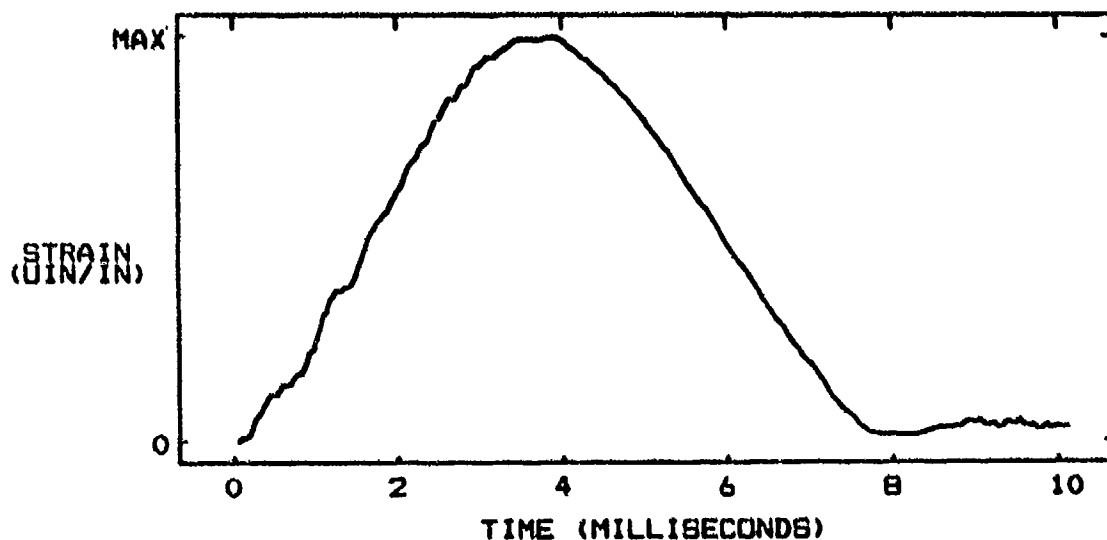
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -5.0 g's      MAXIMUM ACCELERATION 157 g's

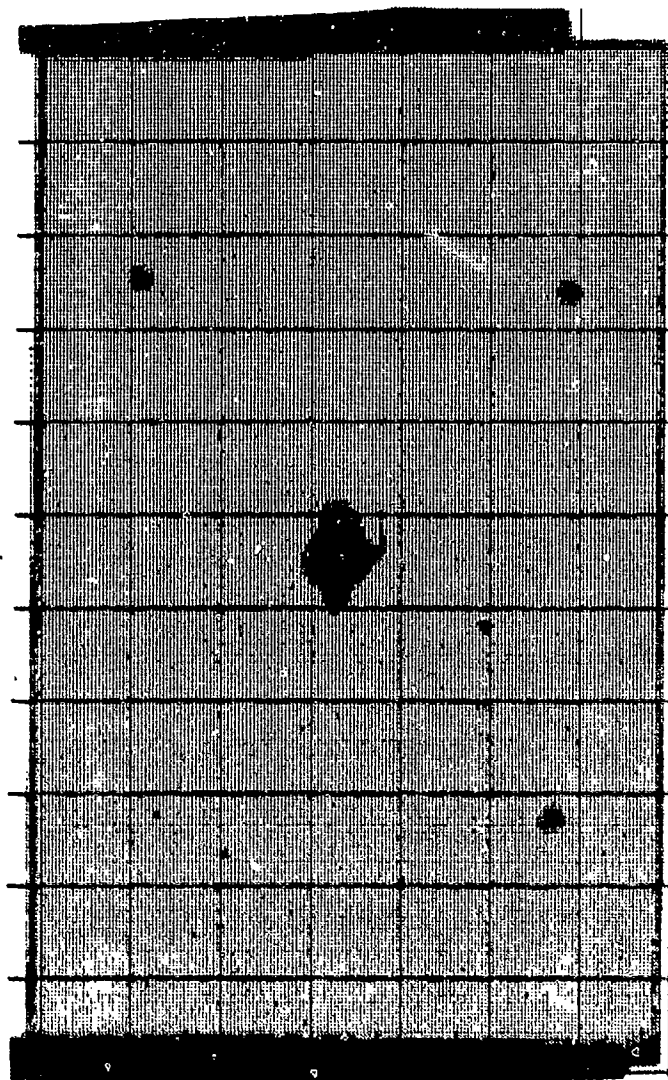
INTEGRATED TOTAL VELOCITY 187.78 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1462 μIN/IN

Figure B-81. Panel 1-14A-1 Second Impact Response Data



**Specimen 1-14A-1**

**Figure B-82. Panel 1-14A-1 C-Scan**

# CSAI - IM6/3100

PANEL 1-14A-1 (RTD)

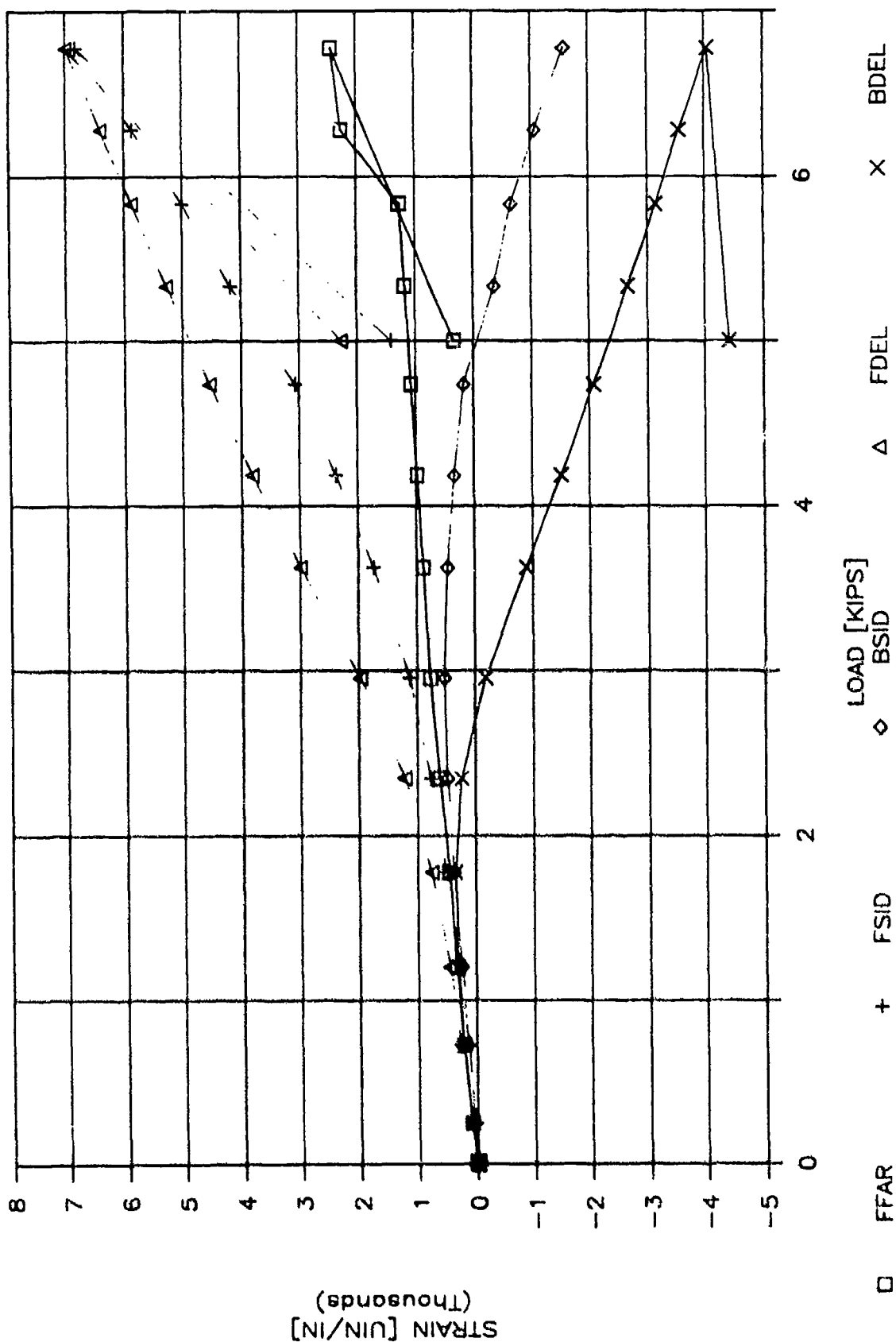


Figure B-83. Panel 1-14A-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

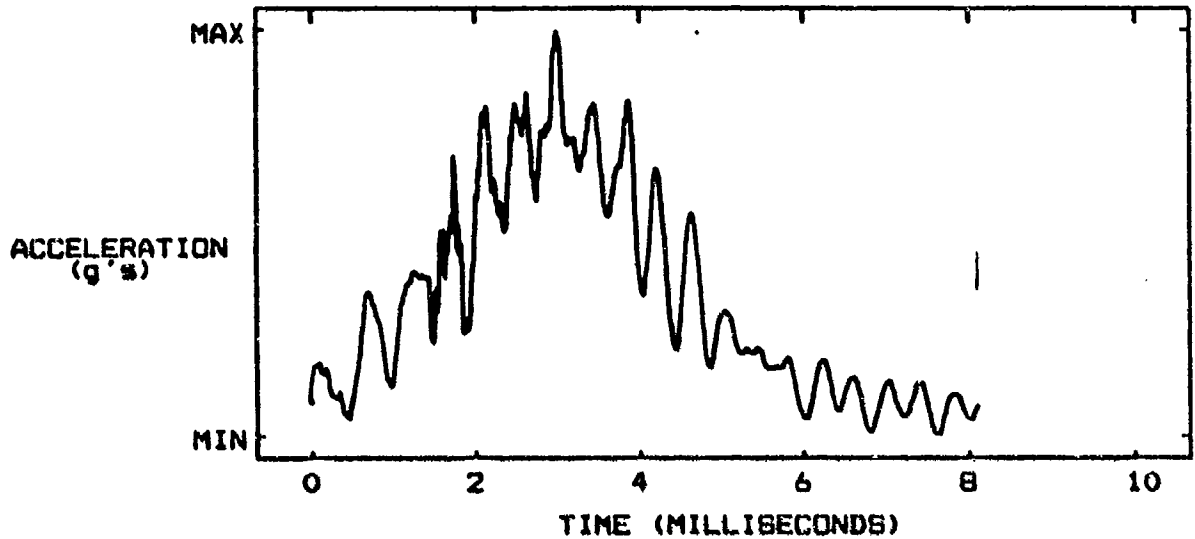
SPECIMEN I.D. 1-19-2.1

THICKNESS .065 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

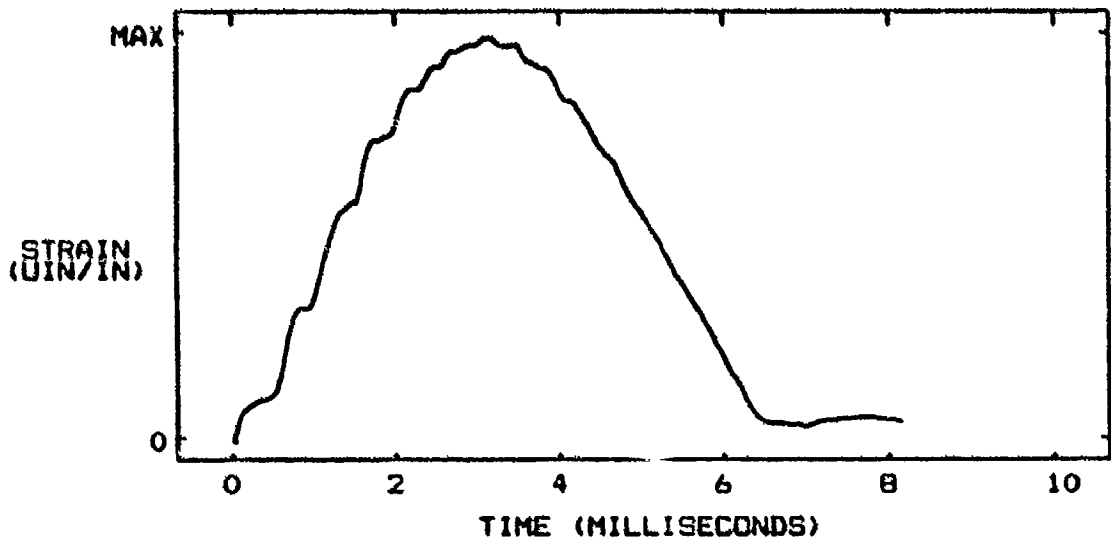
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -16.0 g's      MAXIMUM ACCELERATION 177 g's

INTEGRATED TOTAL VELOCITY 150.25 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1250 UIN/IN

Figure B-84. Panel 1-19-2 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

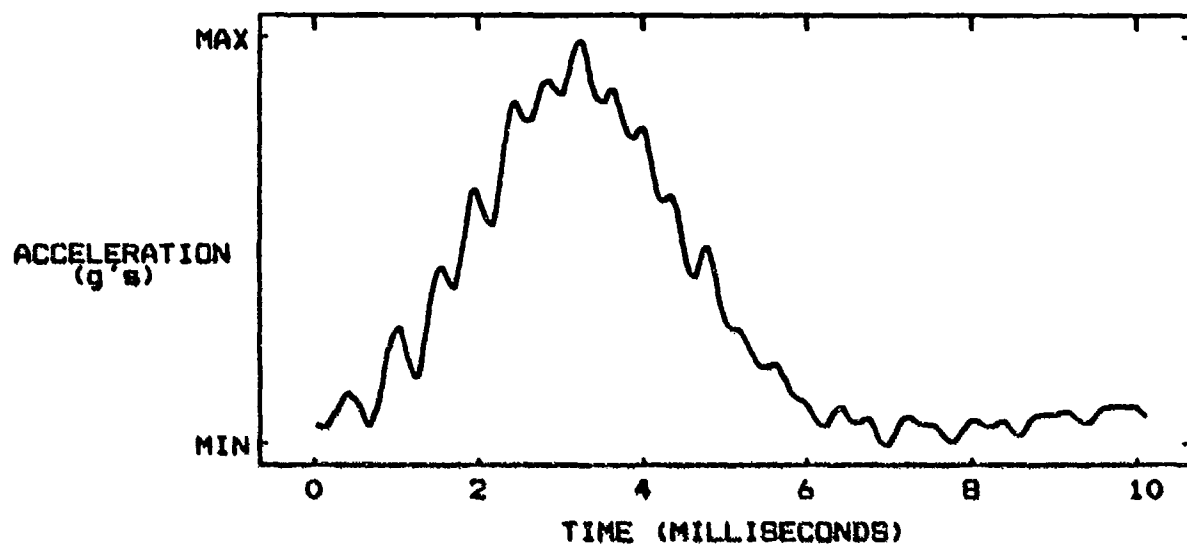
SPECIMEN I.D. 1-19-2.2

THICKNESS .065 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

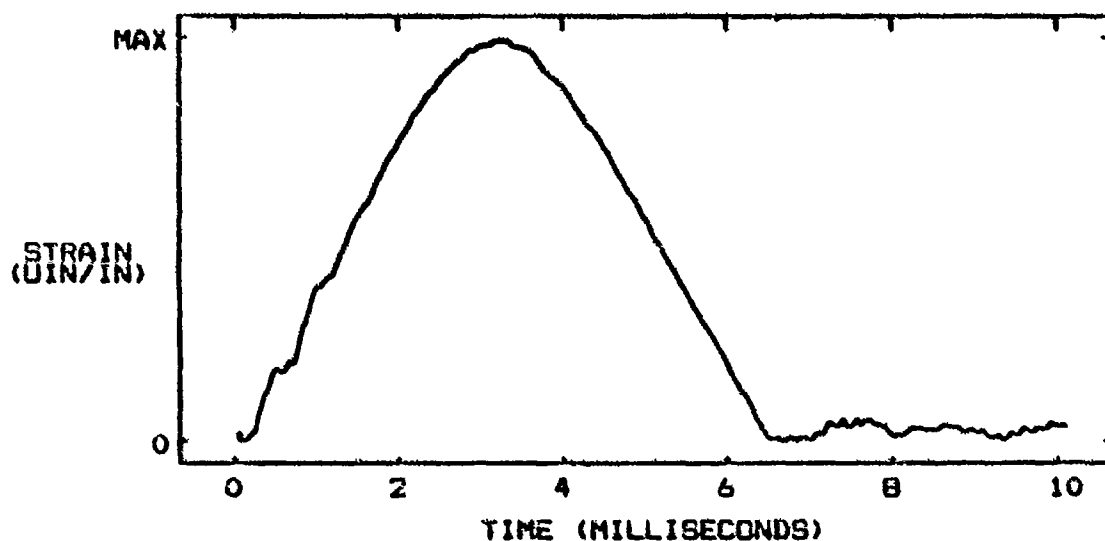
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -8.0 g's      MAXIMUM ACCELERATION 172 g's

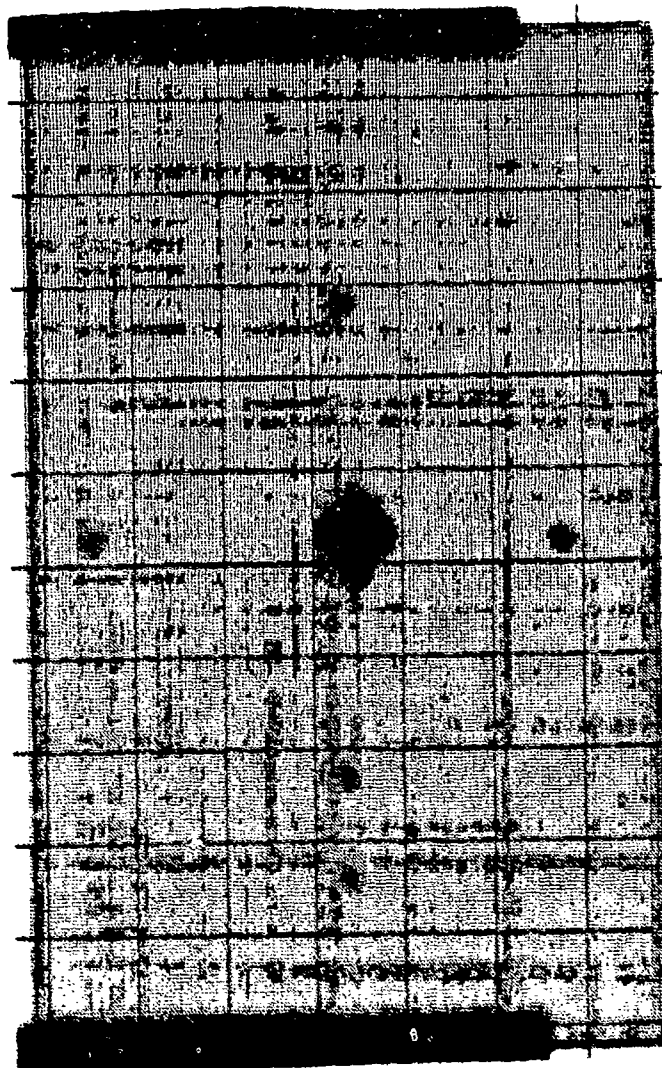
INTEGRATED TOTAL VELOCITY 179.72 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1122 UIN/IN

Figure B-85. Panel 1-19-2 Second Impact Response Data



Specimen 1-19-2

Figure B-88. Panel 1-19-2 C-Scan

# CSAI - IM6/3100

PANEL 1-19-2 (RTD)

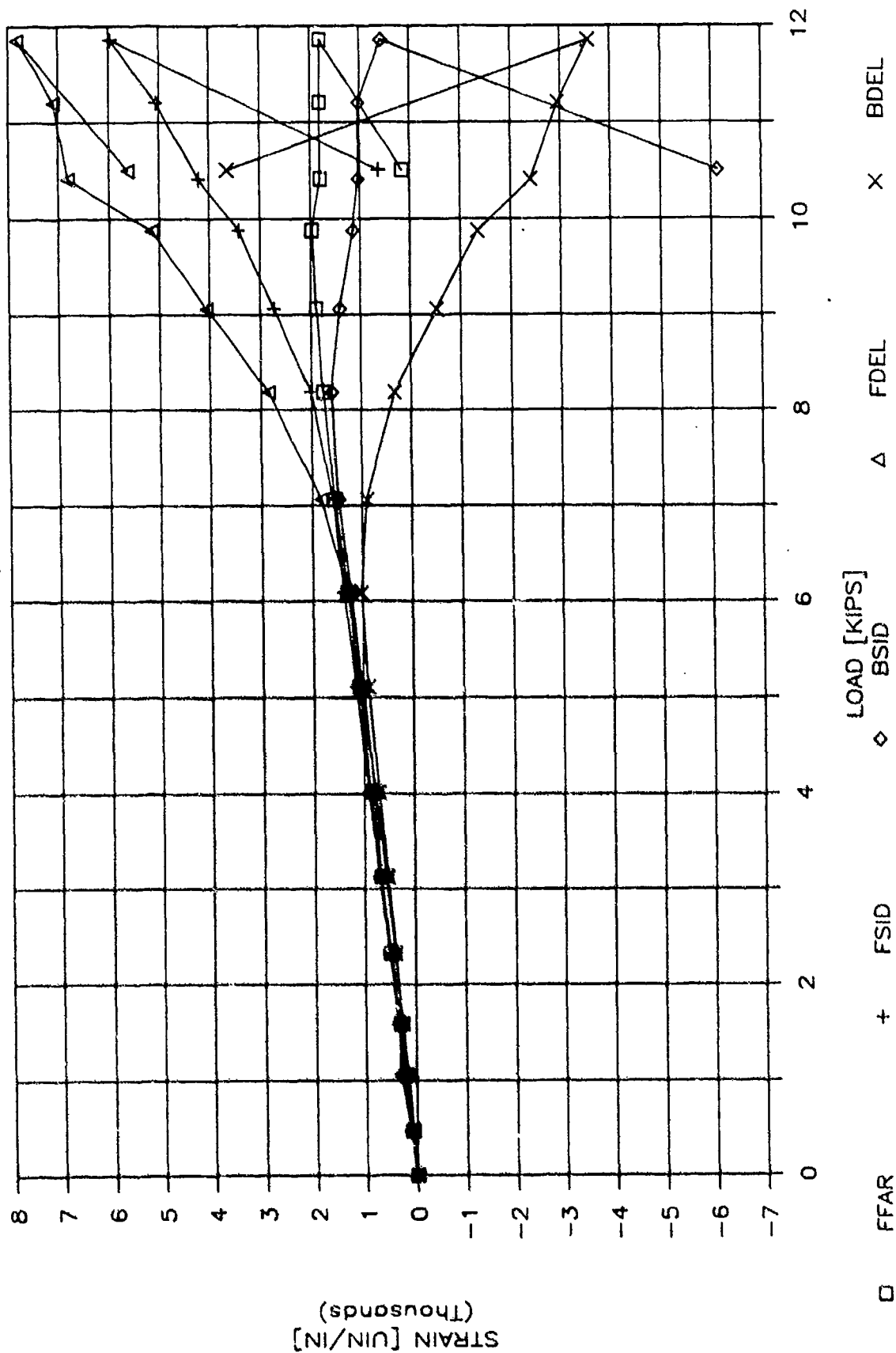


Figure B-87. Panel 1-19-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

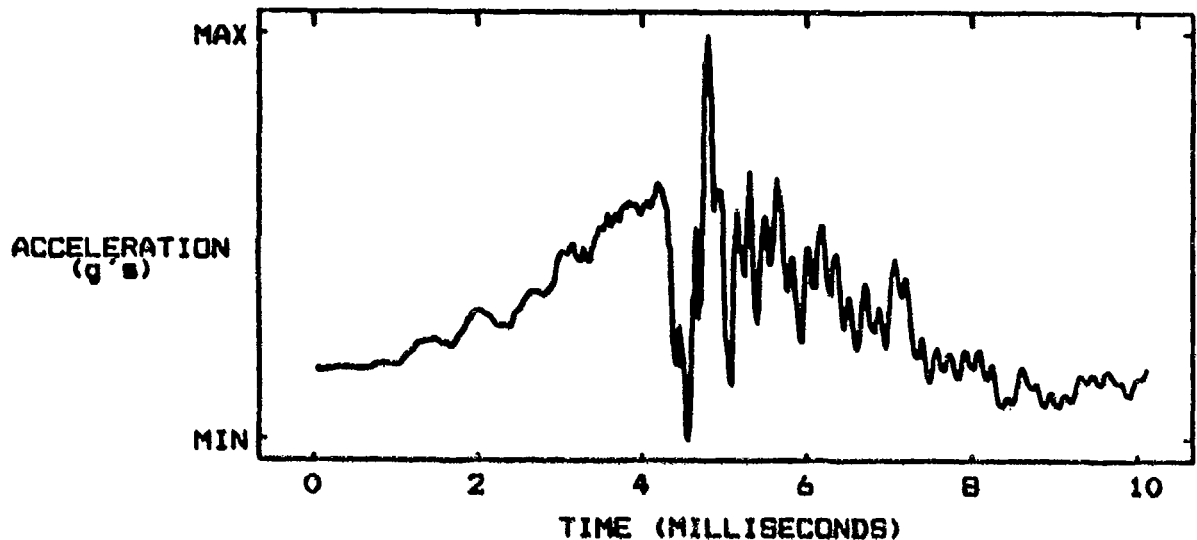
SPECIMEN I.D. 2-16-1

THICKNESS .022 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

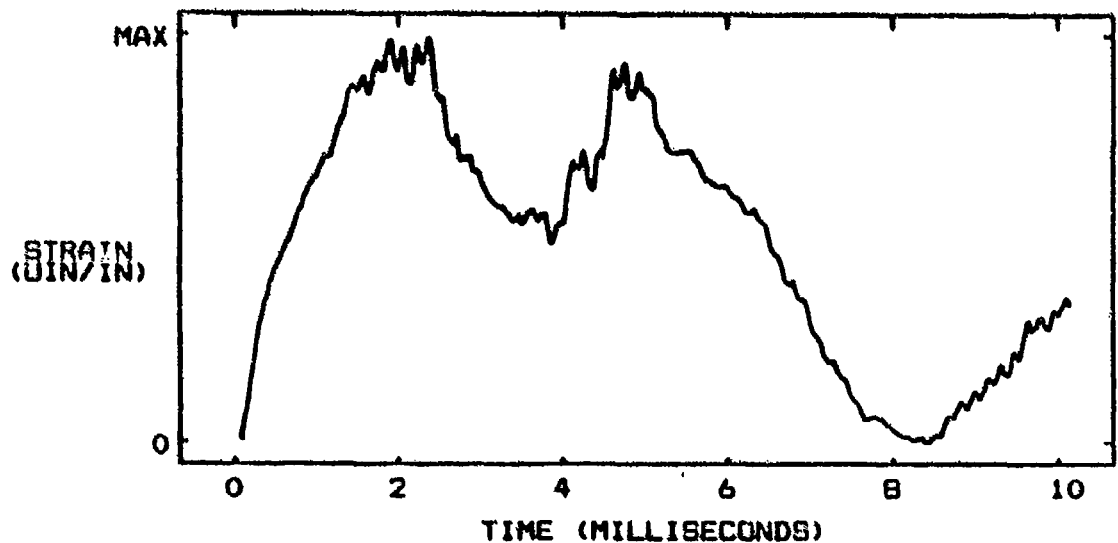
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -27.0 g's      MAXIMUM ACCELERATION 127.8 g's

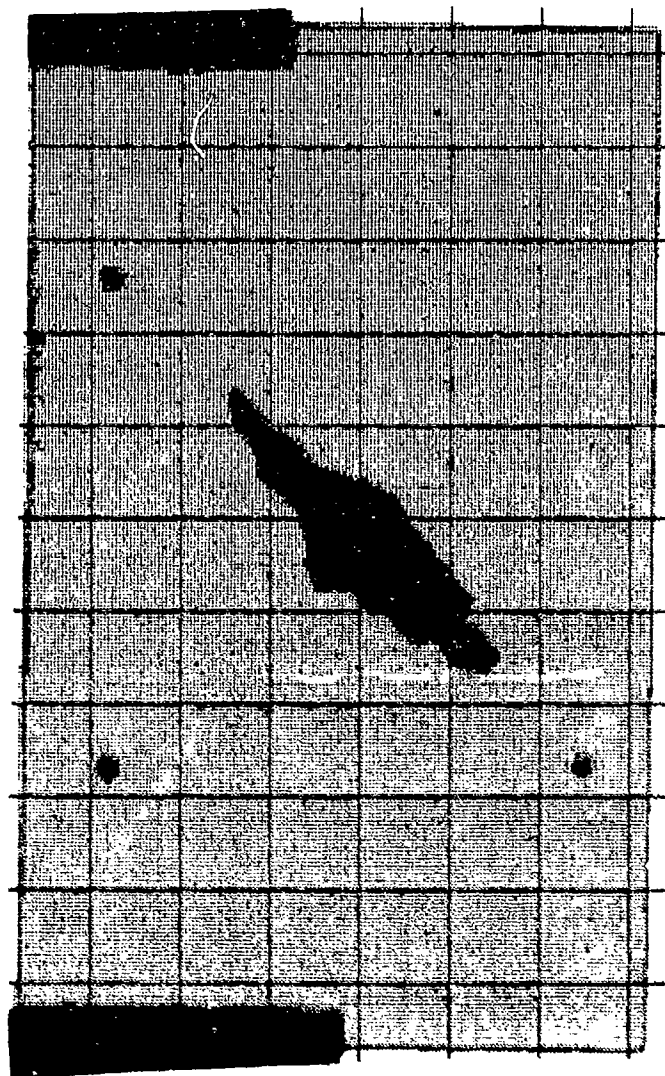
INTEGRATED TOTAL VELOCITY 76.04 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 283 UIN/IN

Figure B-88. Panel 2-16-1 Impact Response Data



Specimen 2-16-1

Figure B-89. Panel 2-16-1 C-Scan

# CSAI - IM6/F650

PANEL 2-16-1 (RTD)

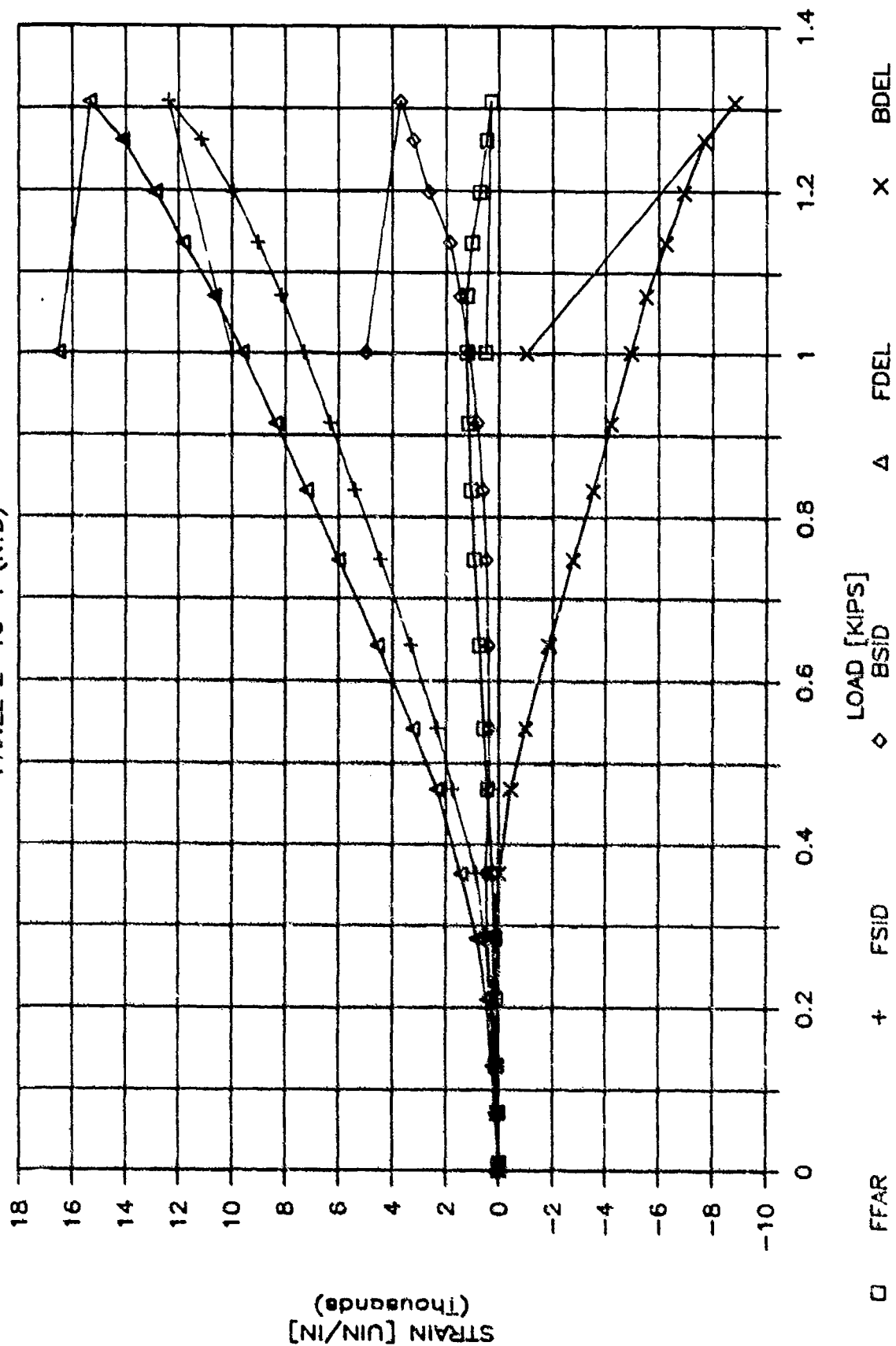


Figure B-90. Panel 2-16-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

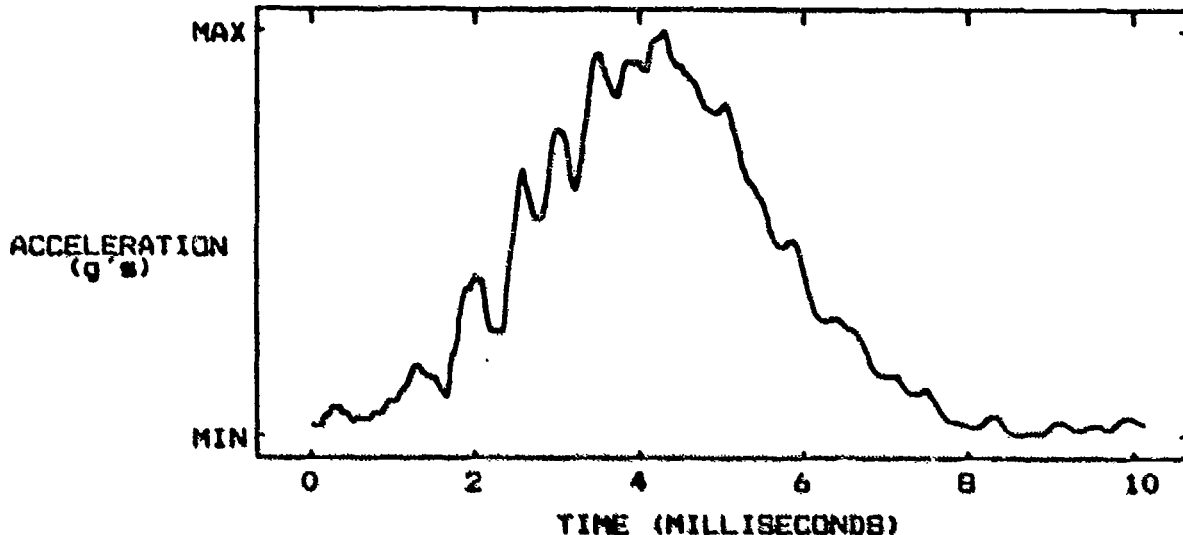
SPECIMEN I.D. 2-12A-1

THICKNESS .044 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

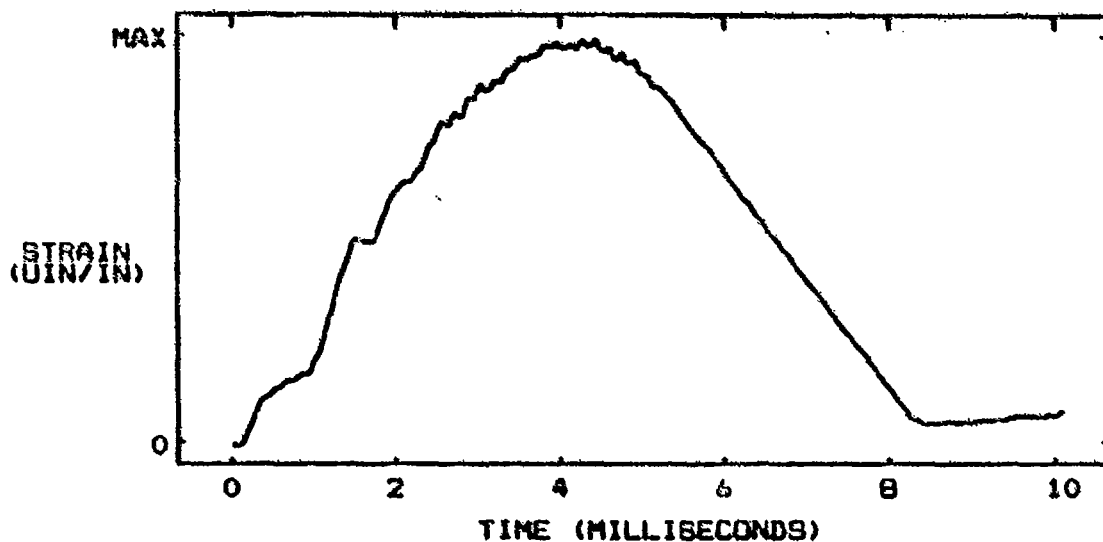
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -3.0 g's      MAXIMUM ACCELERATION 137 g's

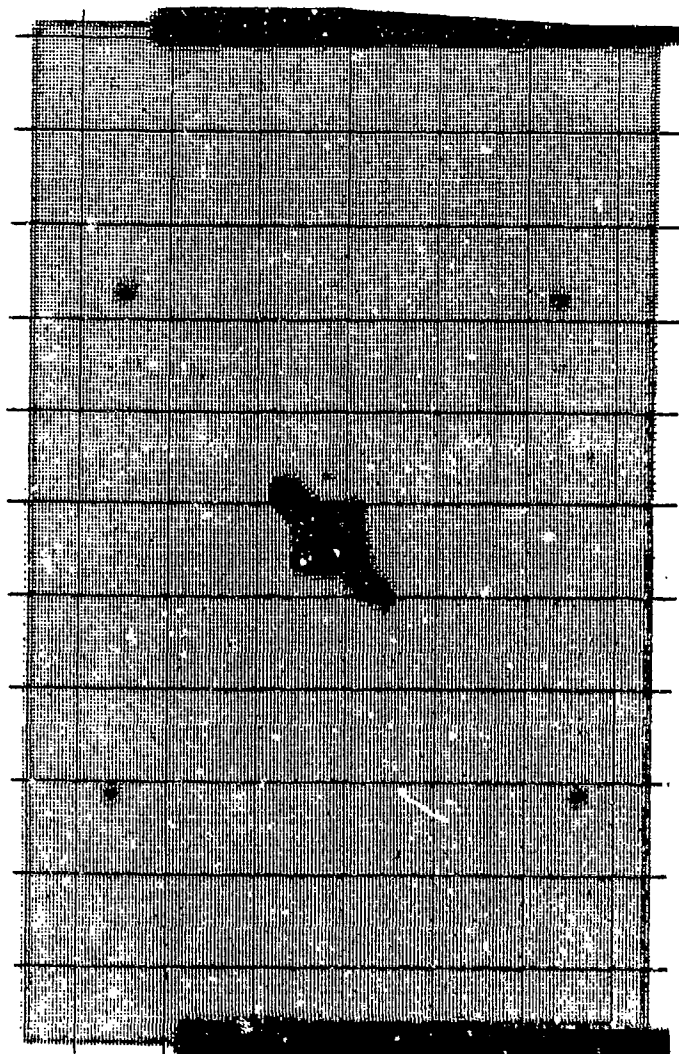
INTEGRATED TOTAL VELOCITY 167.2 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1086 UIN/IN

Figure B-91. Panel 2-12A-1 Impact Response Data



Specimen 2-12A-1

Figure B-92. Panel 2-12A-1 C-Scan

# CSAI - IM6/F650

PANEL 2-12A-1 (RTD)

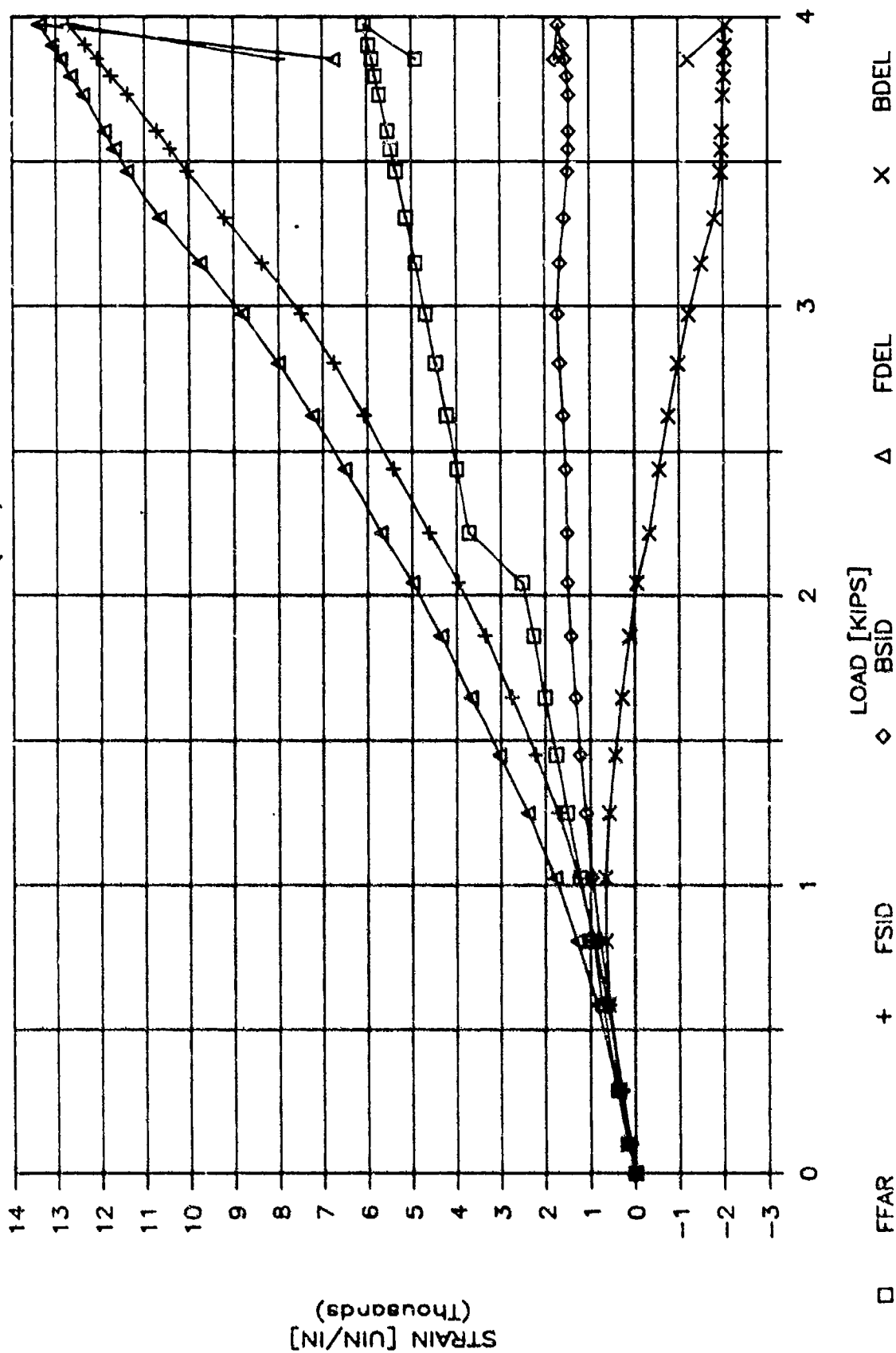


Figure B-93. Panel 2-12A-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

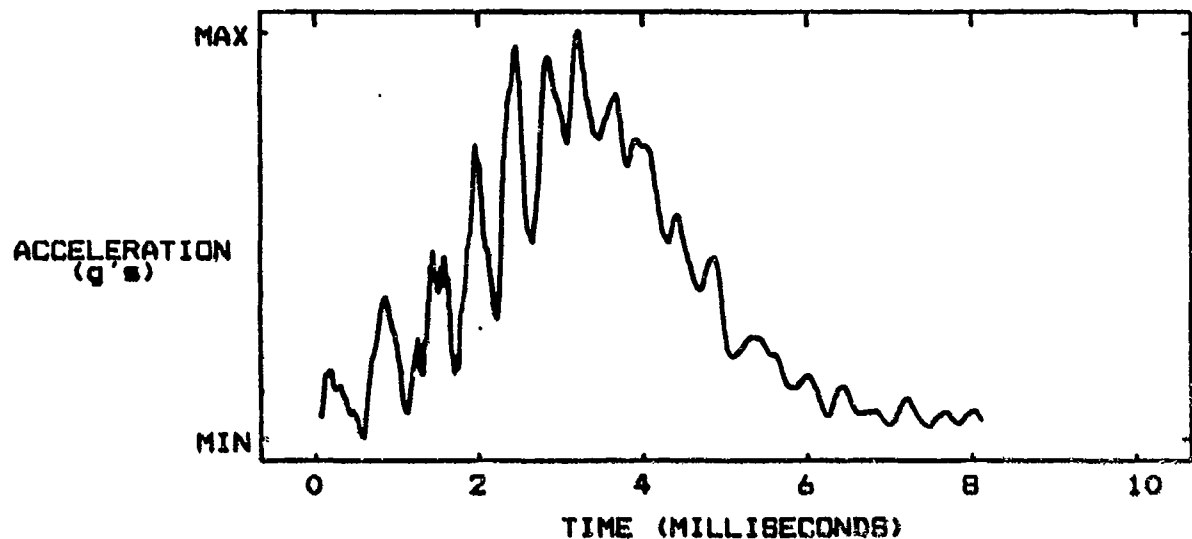
SPECIMEN I.D. 2-17-2

THICKNESS .064 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

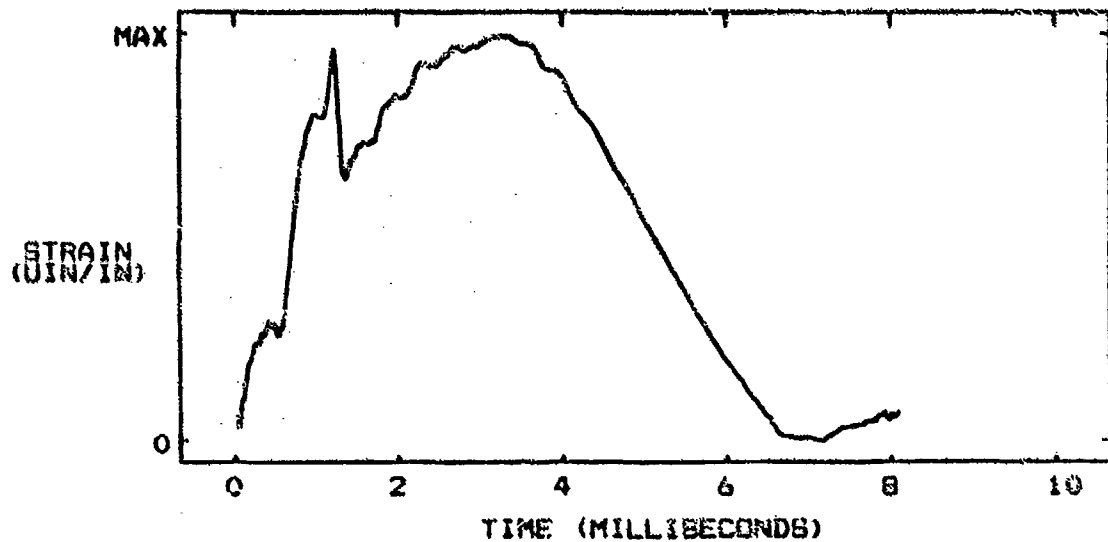
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -10.0 g's      MAXIMUM ACCELERATION 176.72 g's

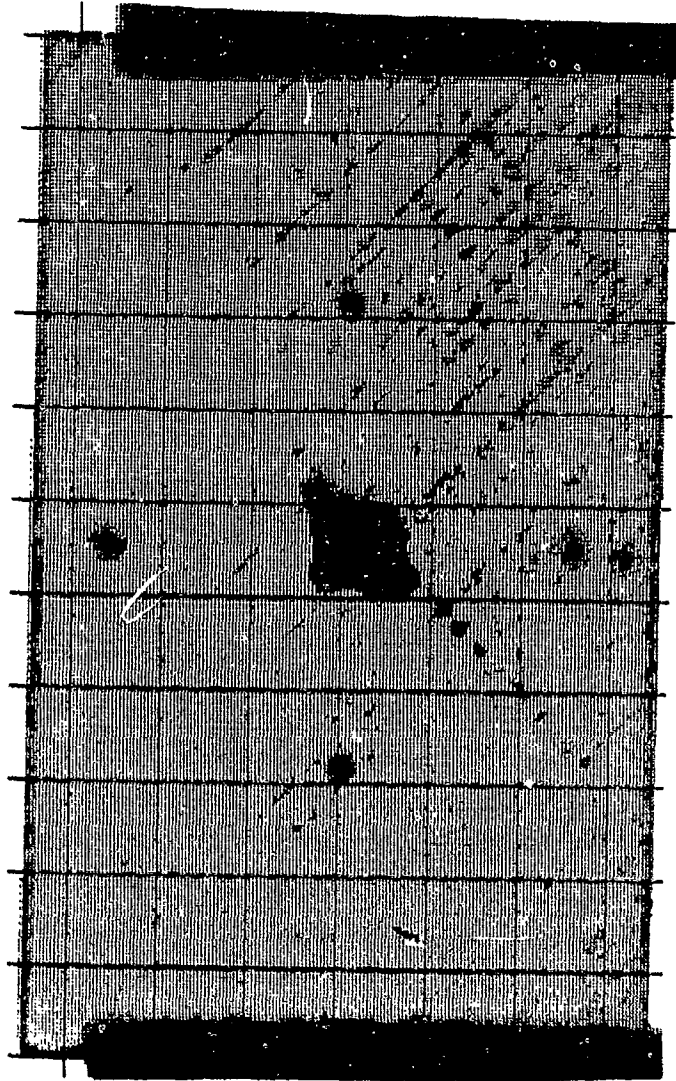
INTEGRATED TOTAL VELOCITY 162.73 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 495 UIN/IN

Figure B-94. Panel 2-17-2 Impact Response Data



Specimen 2-17-2

Figure B-95. Panel 2-17-2 C-Scan

# CSAI — IM6/F650

PANEL 2-17-2 (RTD)

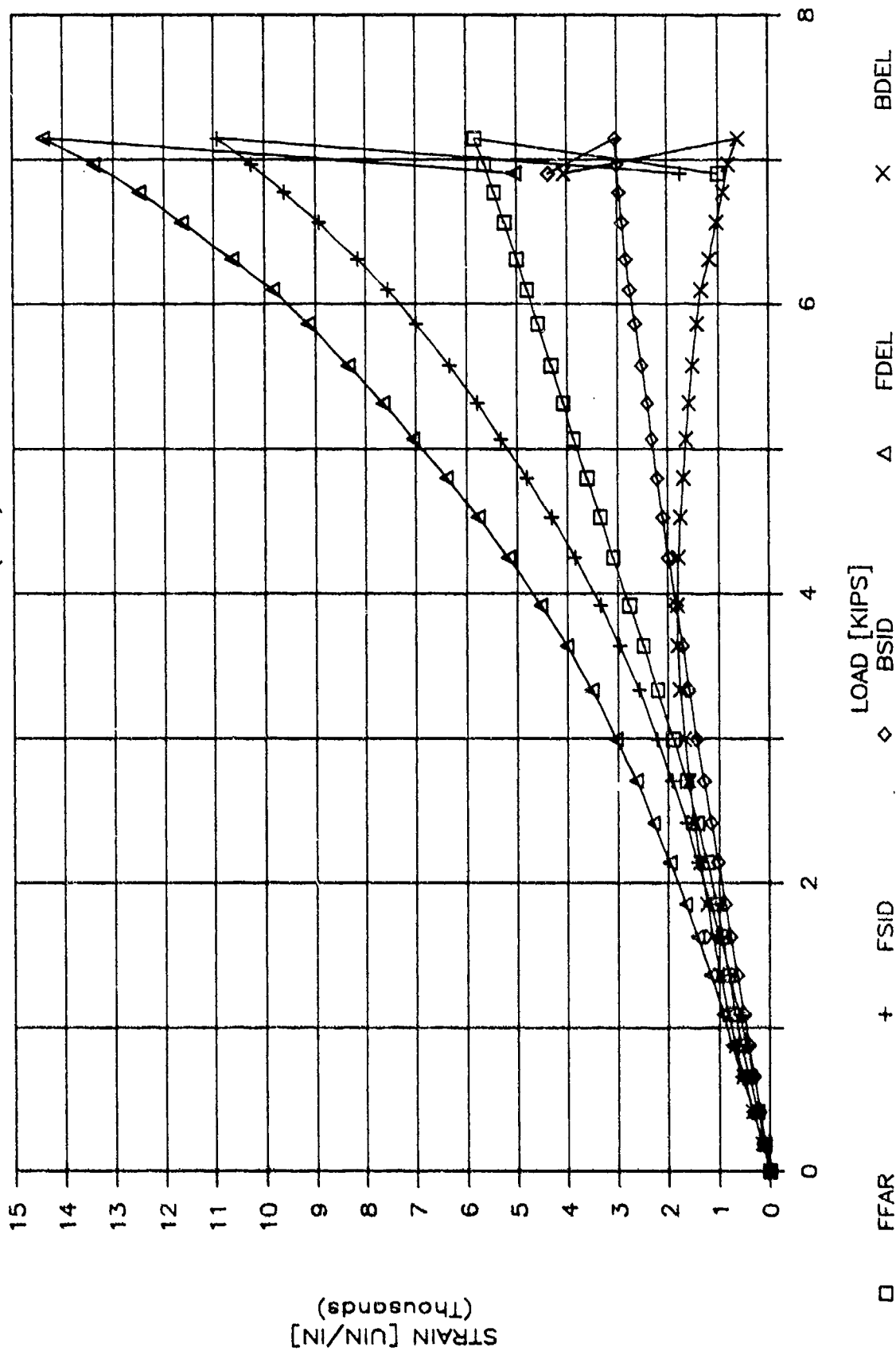


Figure B-96. Panel 2-17-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

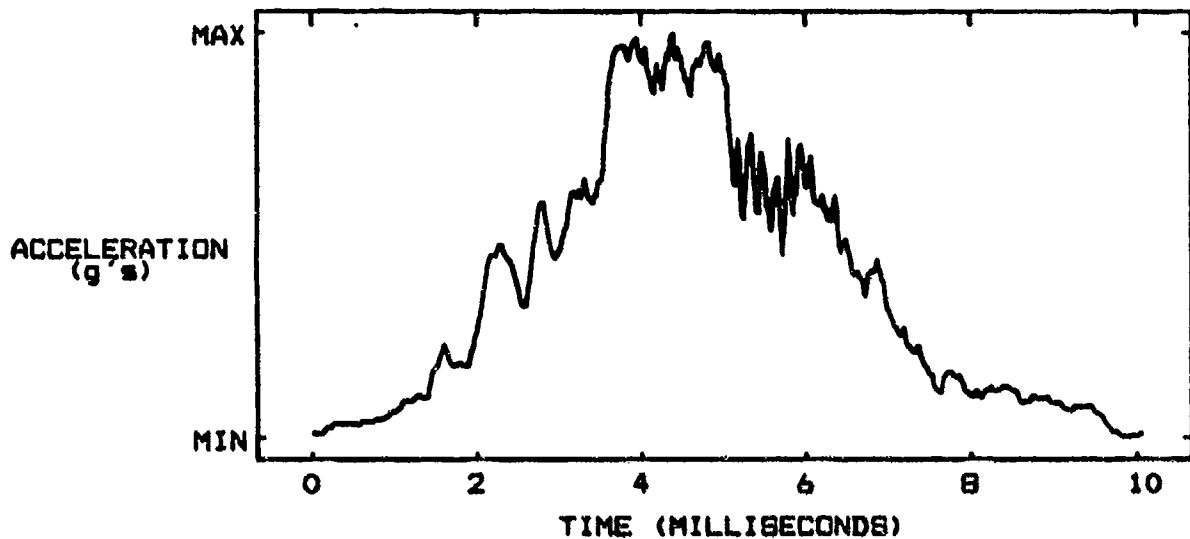
SPECIMEN I.D. 2-18-2

THICKNESS .023 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

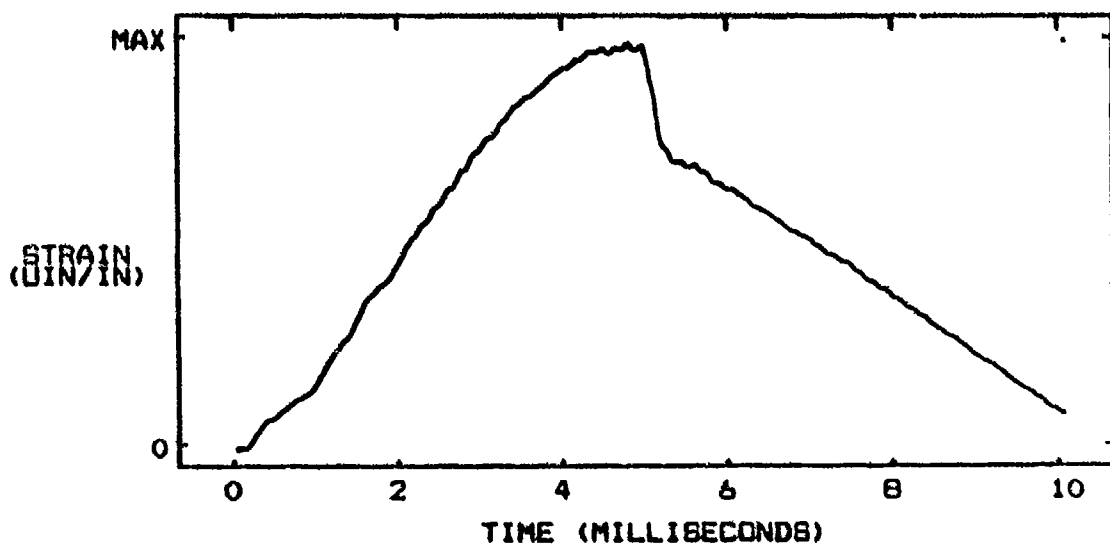
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION 0.0 g's      MAXIMUM ACCELERATION 75 g's

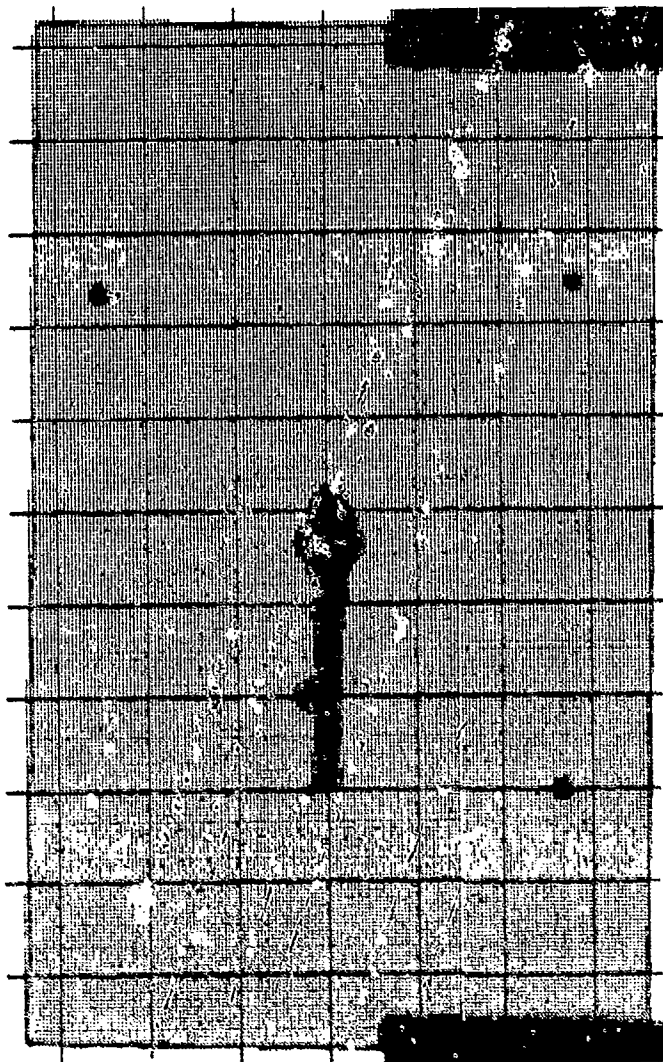
INTEGRATED TOTAL VELOCITY 111.21 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1334 UIN/IN

Figure B-97. Panel 2-18-2 Impact Response Data



Specimen 2-18-2

Figure B-88. Panel 2-18-2 C-Scan

# CSAI - IM6/F650

PANEL 2-18-2 (RTD)

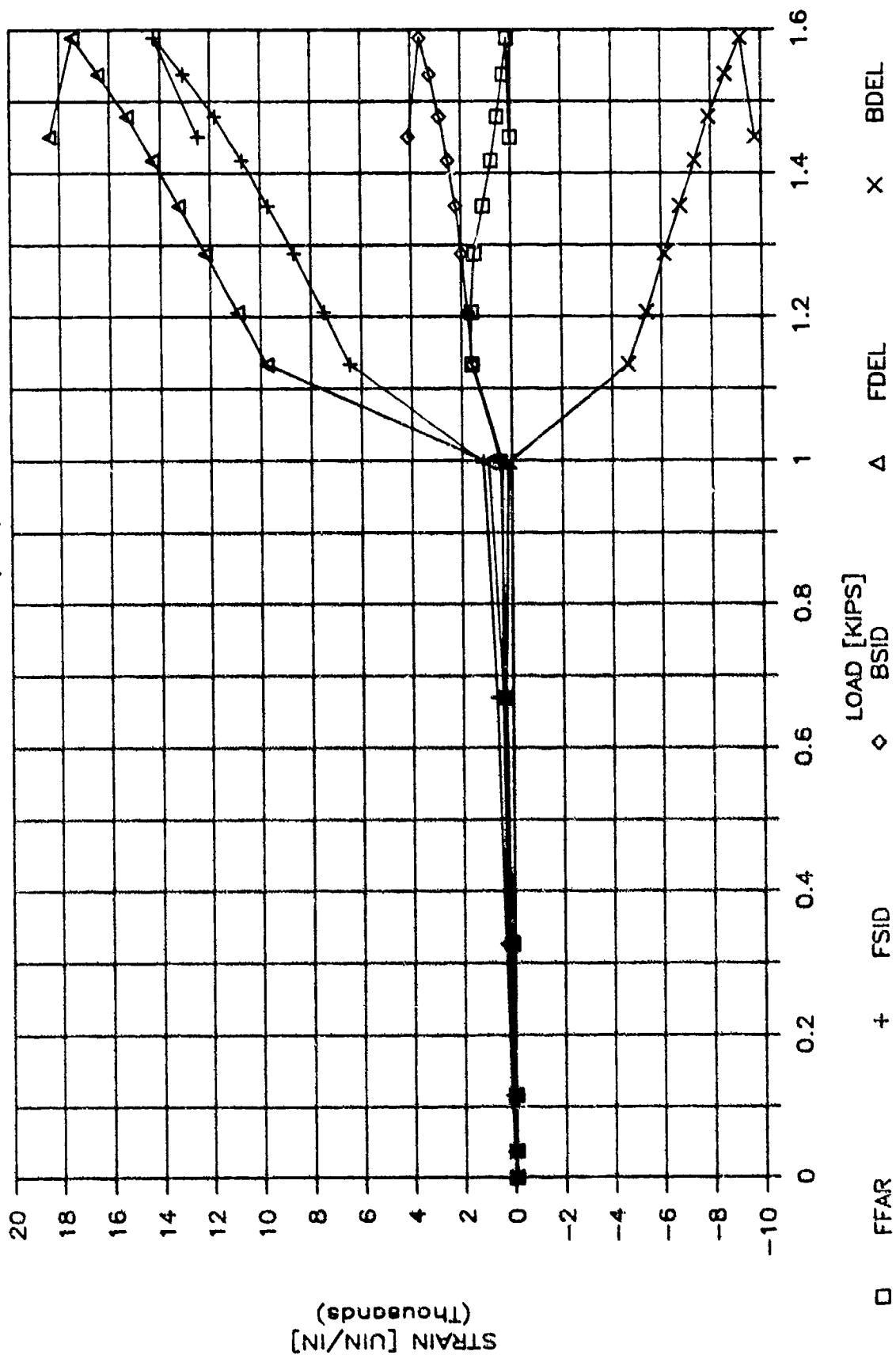


Figure B-99. Panel 2-18-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

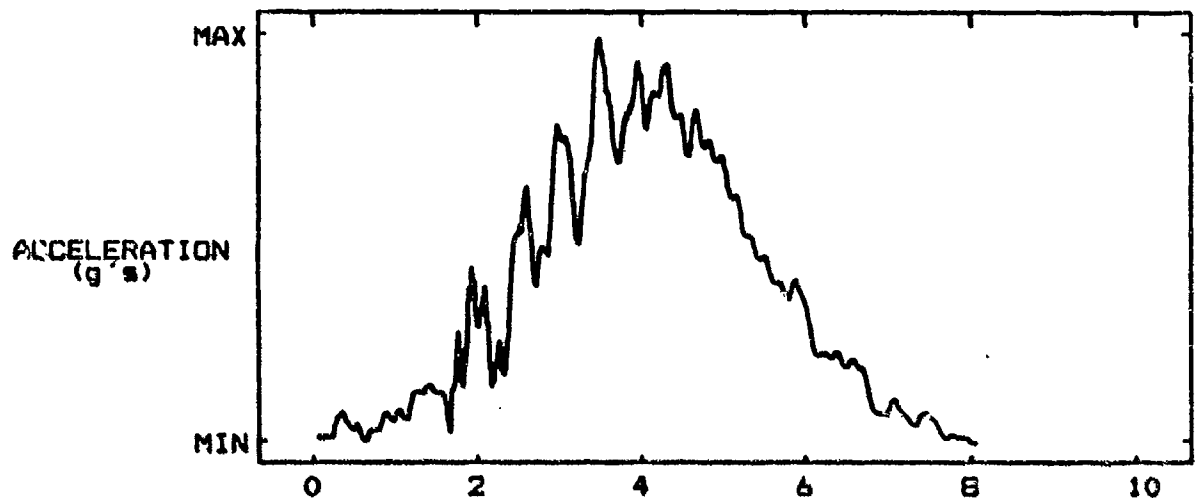
SPECIMEN I.D. 2-14A-1.1

THICKNESS .043 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

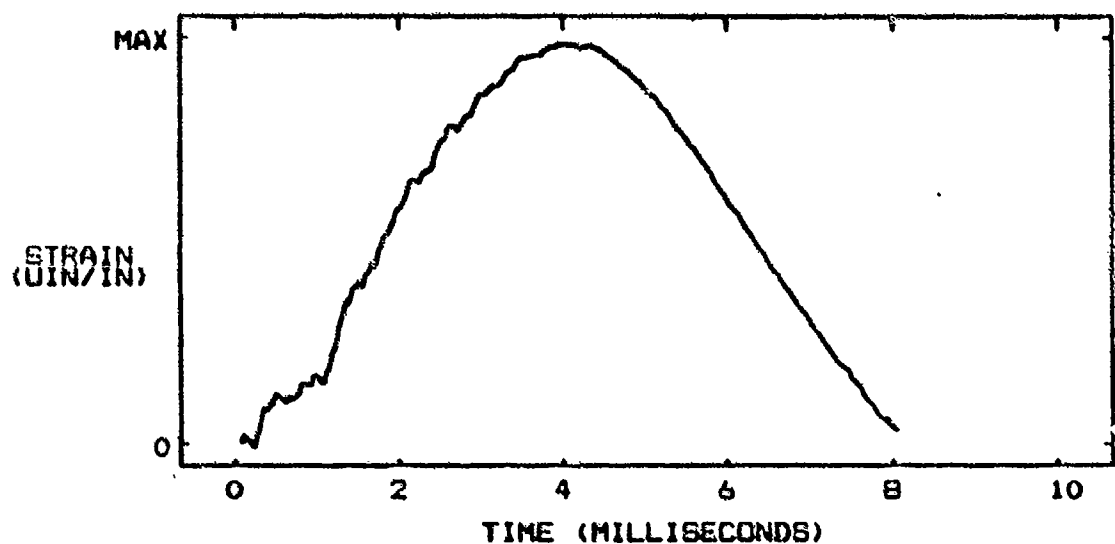
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -3.0 g's      MAXIMUM ACCELERATION 157 g's

INTEGRATED TOTAL VELOCITY 169.29 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1125 μIN/IN

Figure B-100. Panel 2-14A-1 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

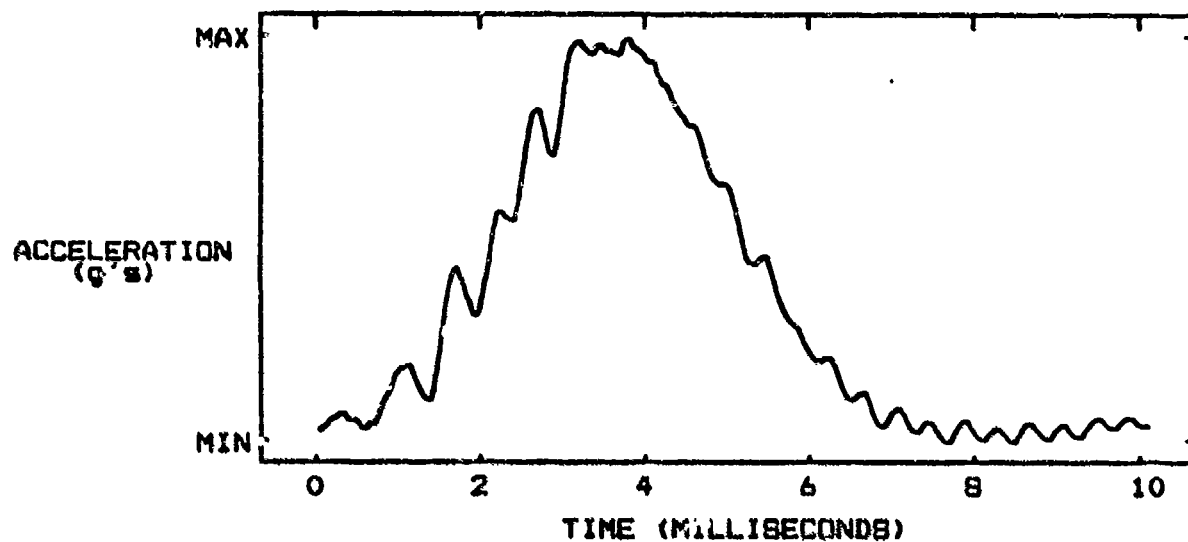
SPECIMEN I.D. 2-14A-1.2

THICKNESS 0.43 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

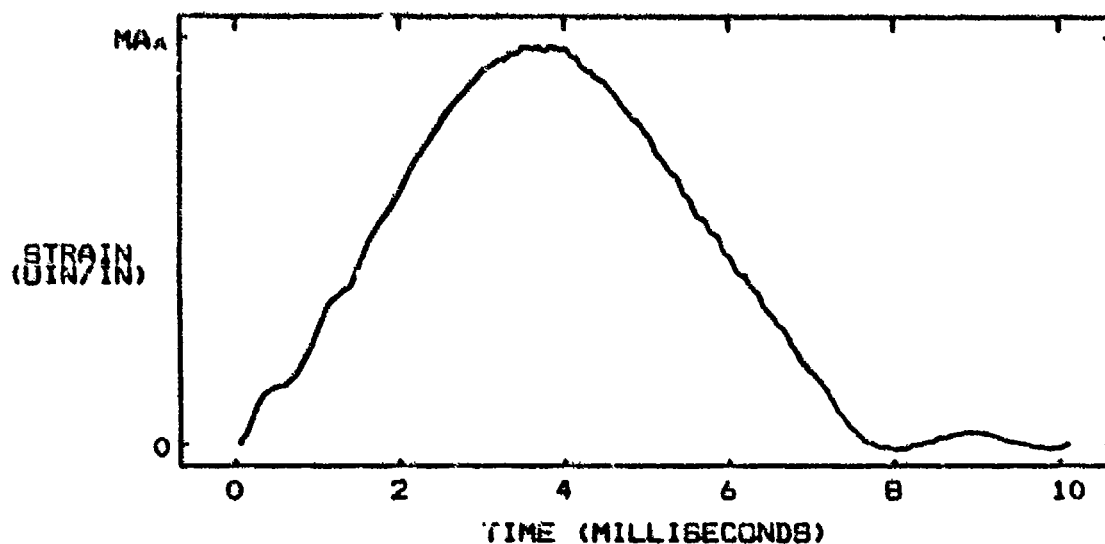
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -5.0 g's      MAXIMUM ACCELERATION 158 g's

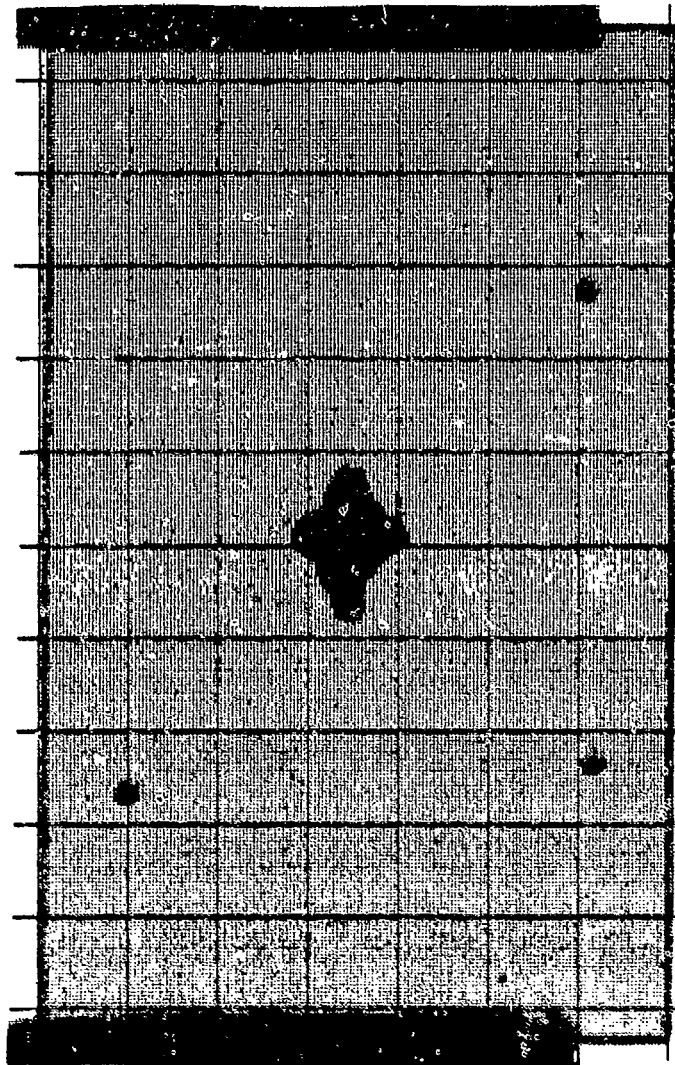
INTEGRATED TOTAL VELOCITY 191.44 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1231 μIN/IN

Figure B-101. Panel 2-14A-1 Second Impact Response Data



Specimen 2-14A-1

Figure B-102. Panel 2-14A-1 C-Scan

# CSA1 - IM6/F650

PANEL 2-14A-1 (RTD)

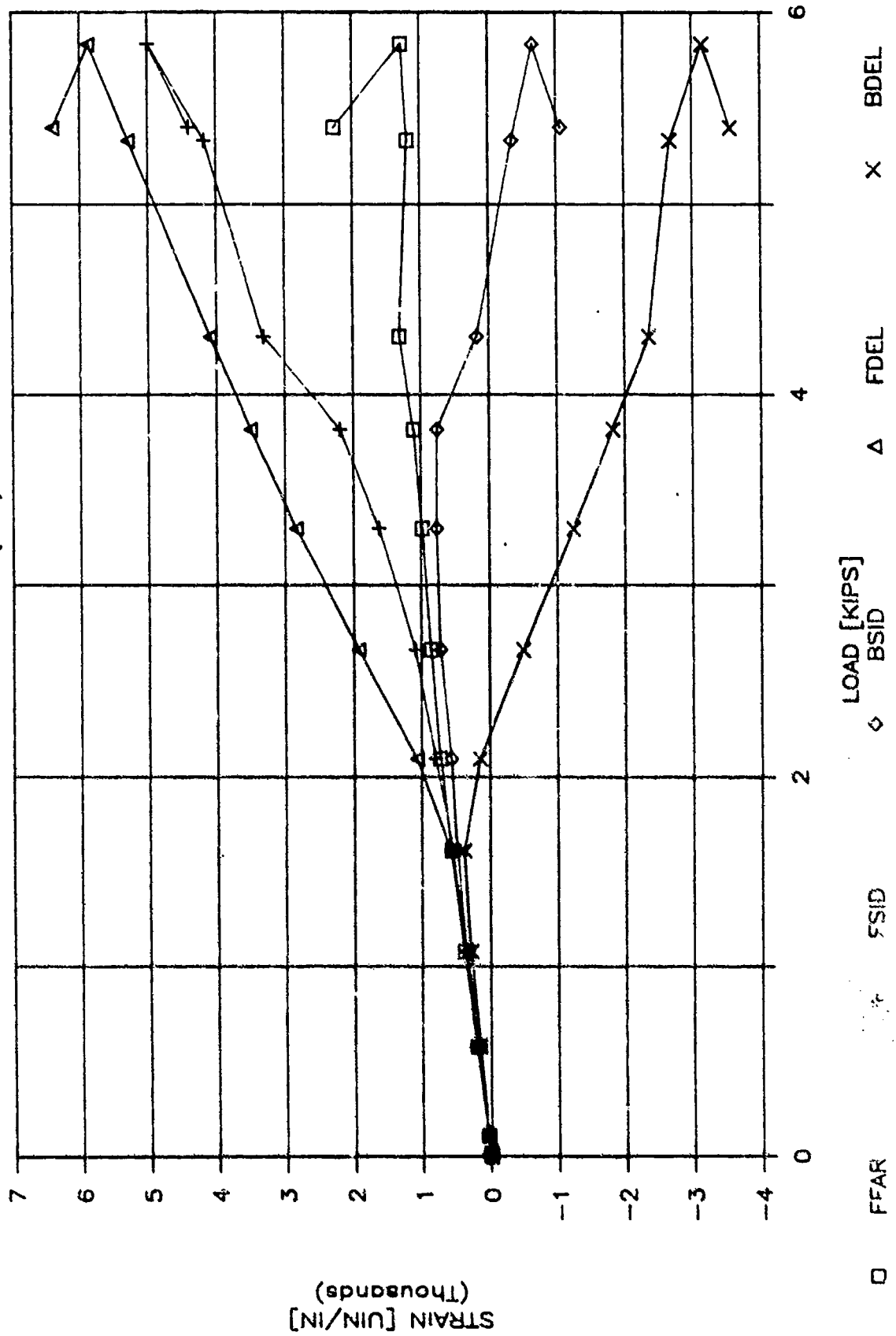


Figure 8-103. Panel 2-14A-1 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

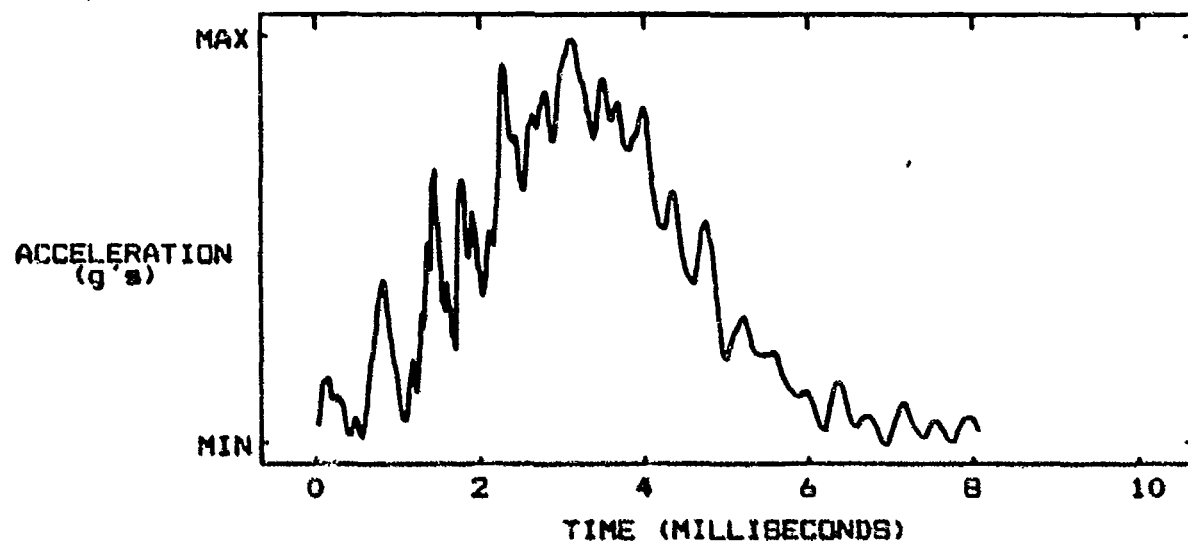
SPECIMEN I.D. 2-19-2.1

THICKNESS .064 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

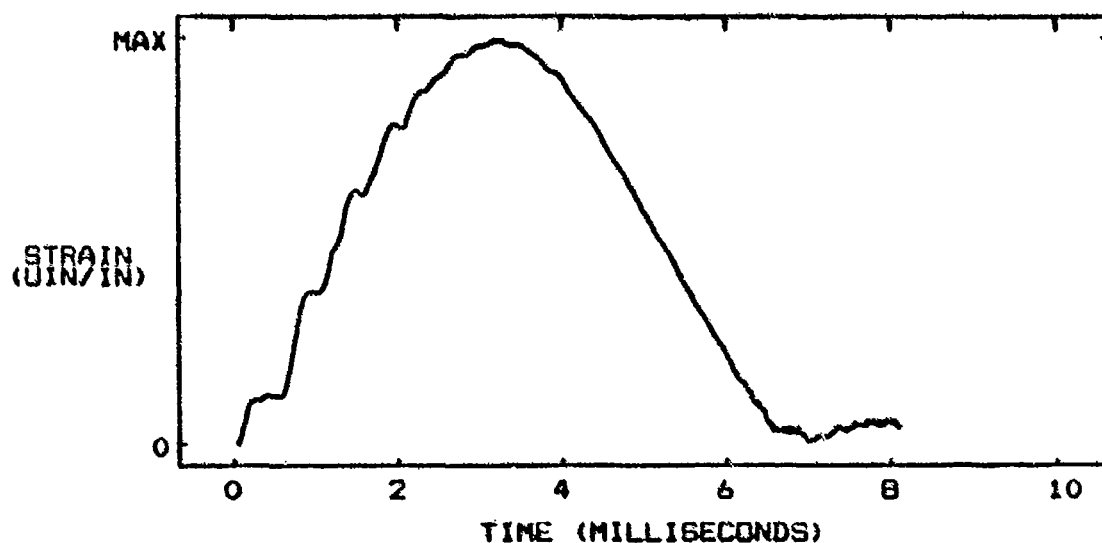
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -6.0 g's      MAXIMUM ACCELERATION 166 g's

INTEGRATED TOTAL VELOCITY 166.77 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1025 IN/IN

Figure B-104. Panel 2-19-2 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

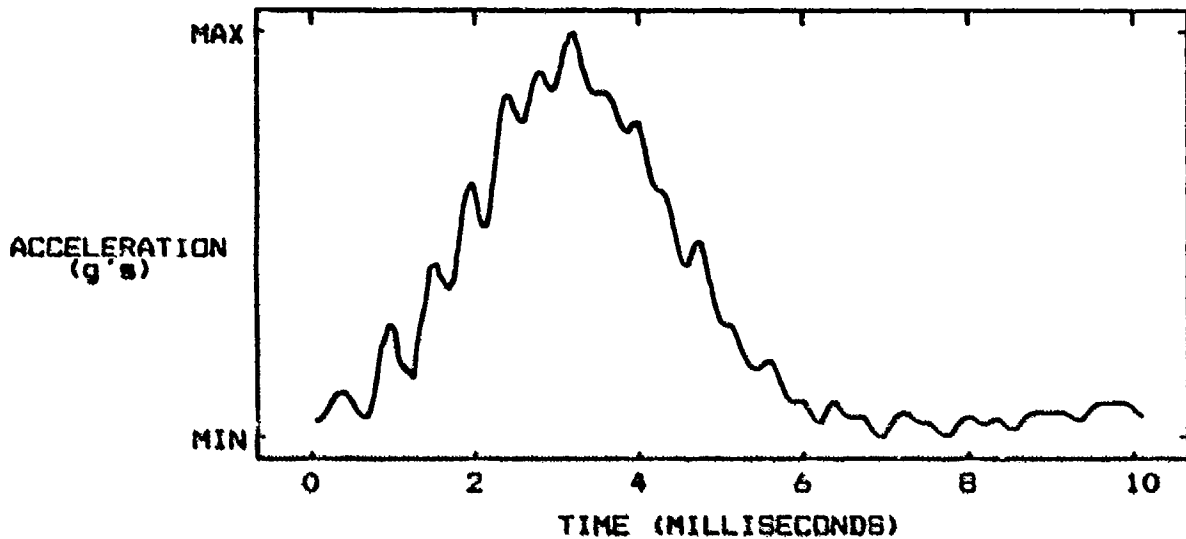
SPECIMEN I.D. 2-19-2.2

THICKNESS .064 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

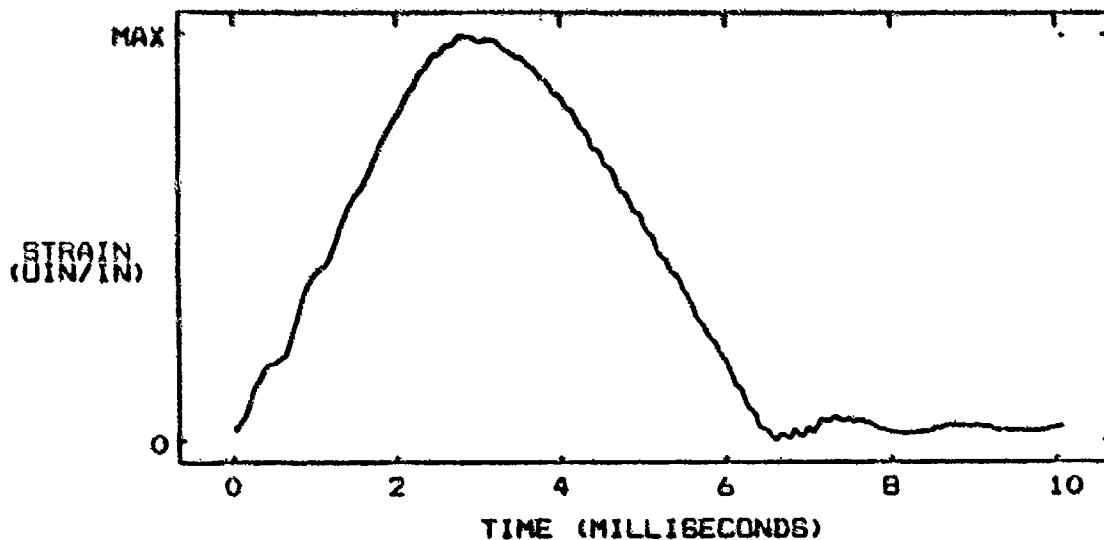
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -8.0 g's      MAXIMUM ACCELERATION 175 g's

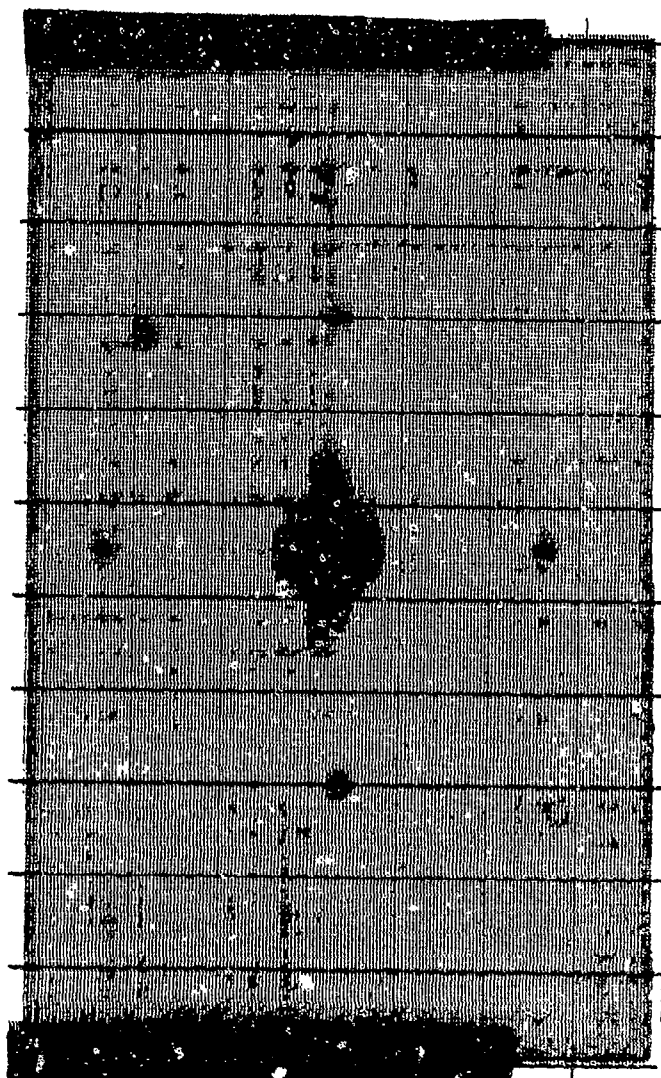
INTEGRATED TOTAL VELOCITY 181.06 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1042 UIN/IN

Figure B-105. Panel 2-19-2 Second Impact Response Data



Specimen 2-19-2

Figure B-106. Panel 2-19-2 C-Scan

8-109

# CSA1 - IM6/F650

PANEL 2-19-2 (RTD)

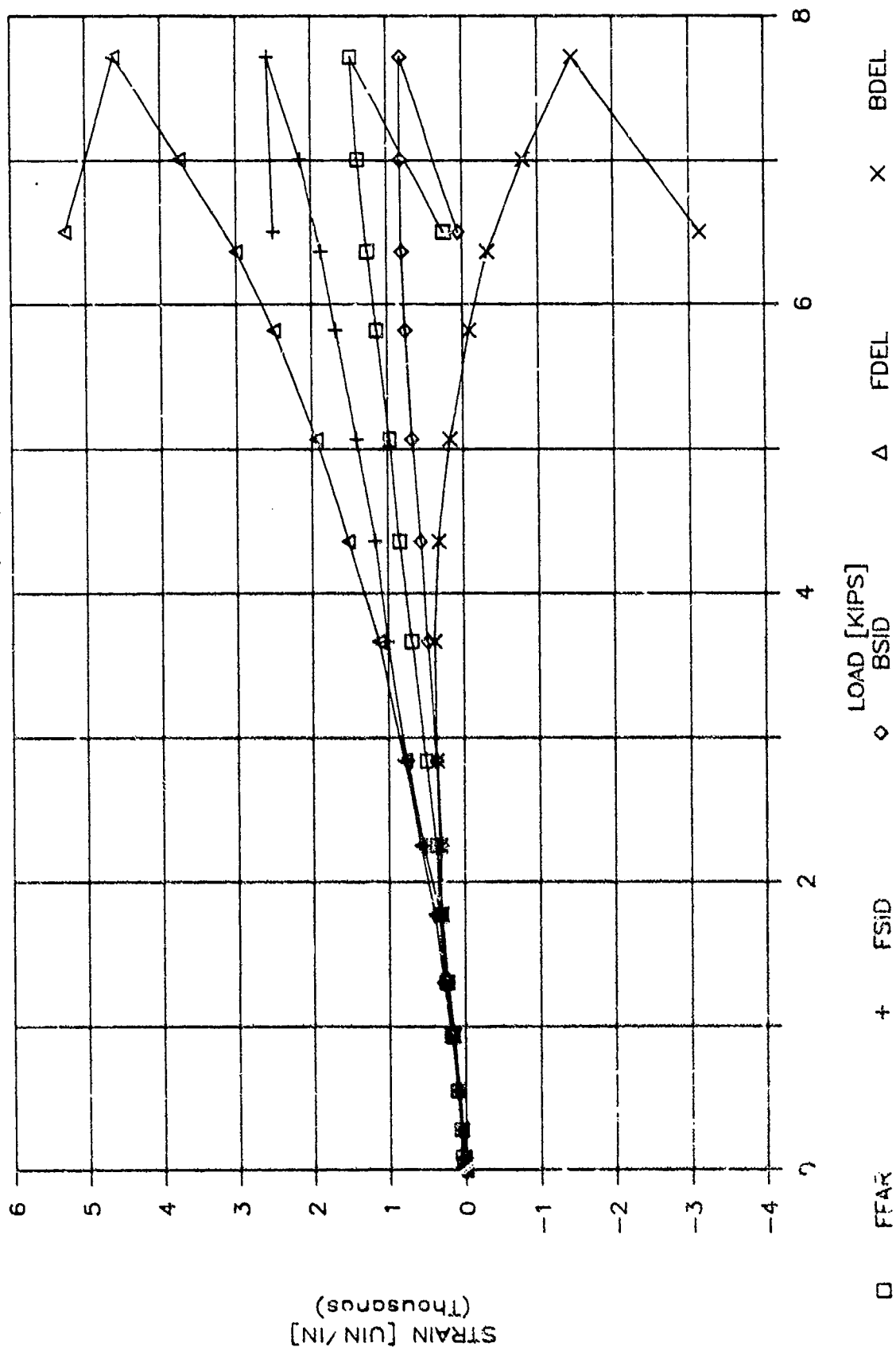


Figure B-107. Panel 2-19-2 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

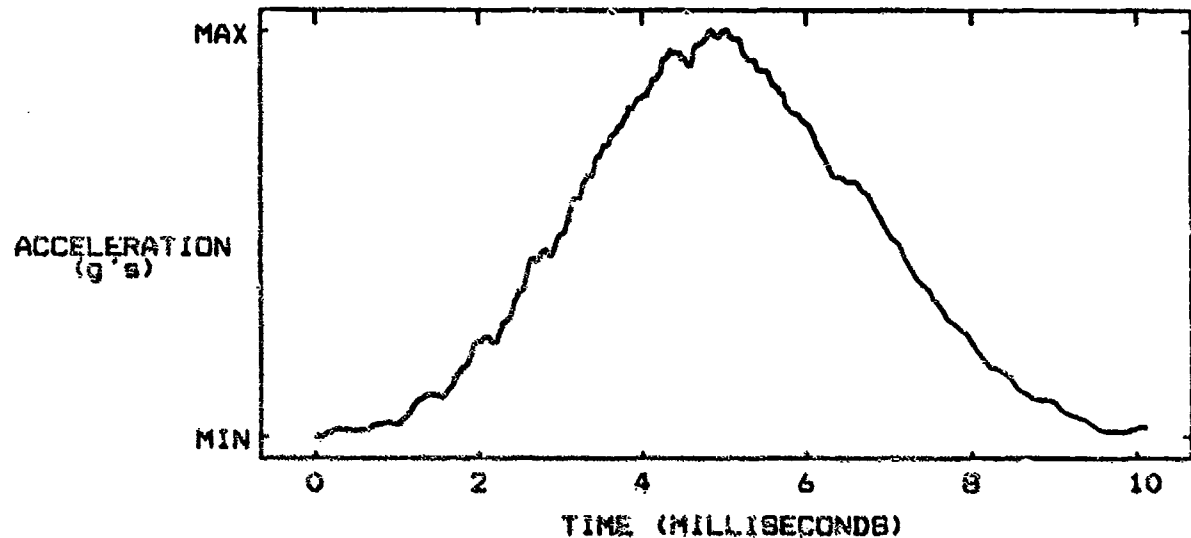
SPECIMEN I.D. 1-16-4

THICKNESS .024 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

### ACCELERATION VERSUS TIME



### PANEL STRAIN VERSUS TIME

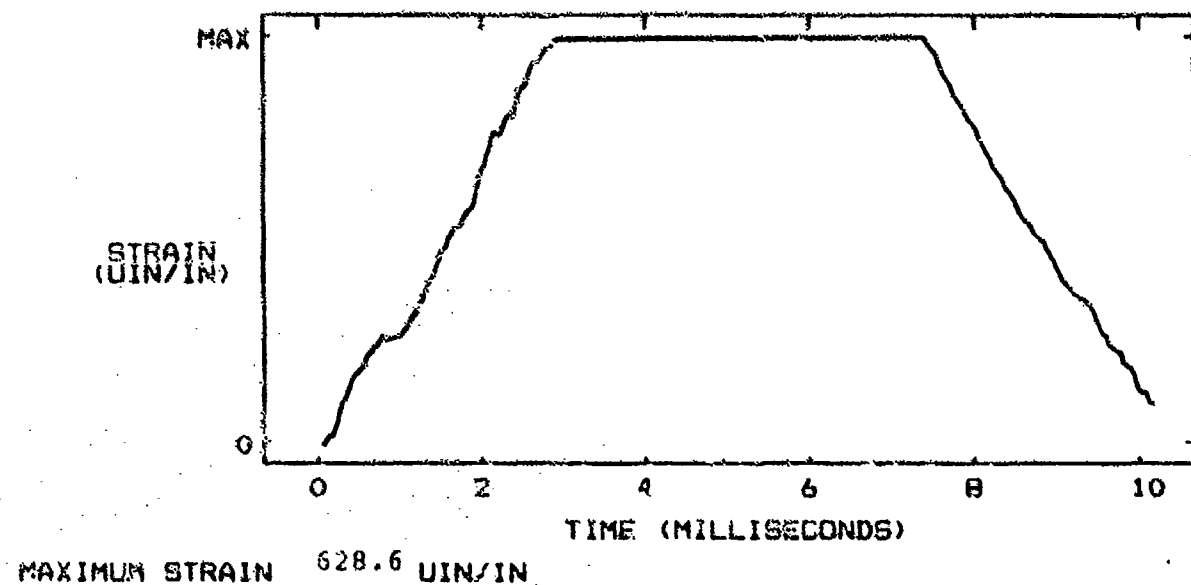


Figure B-108. Panel 1-16-4 Impact Response Data

# CSAI - IM6/3100

PANEL 1-16-4 (ETW)

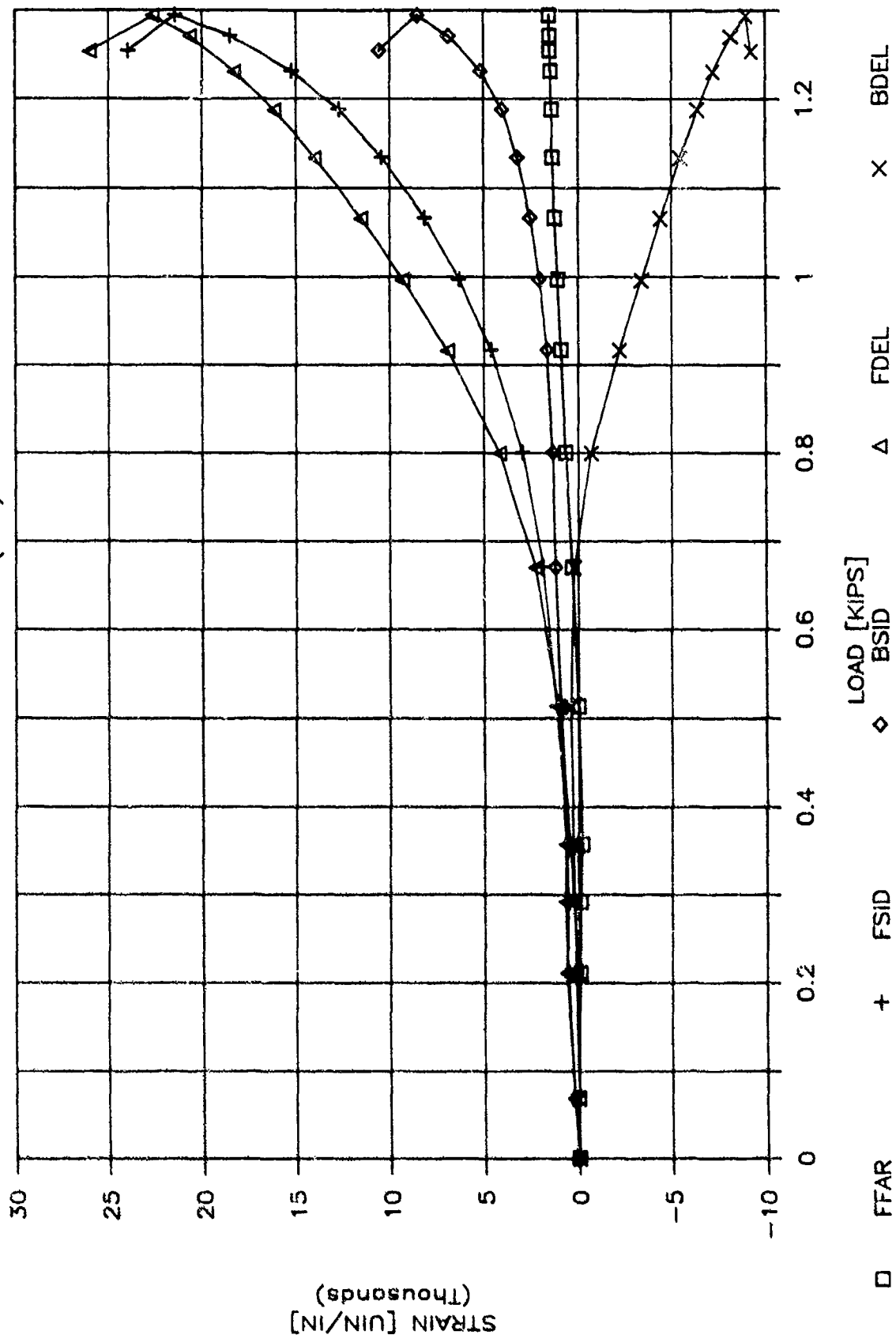


Figure B-109. Panel 1-16-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

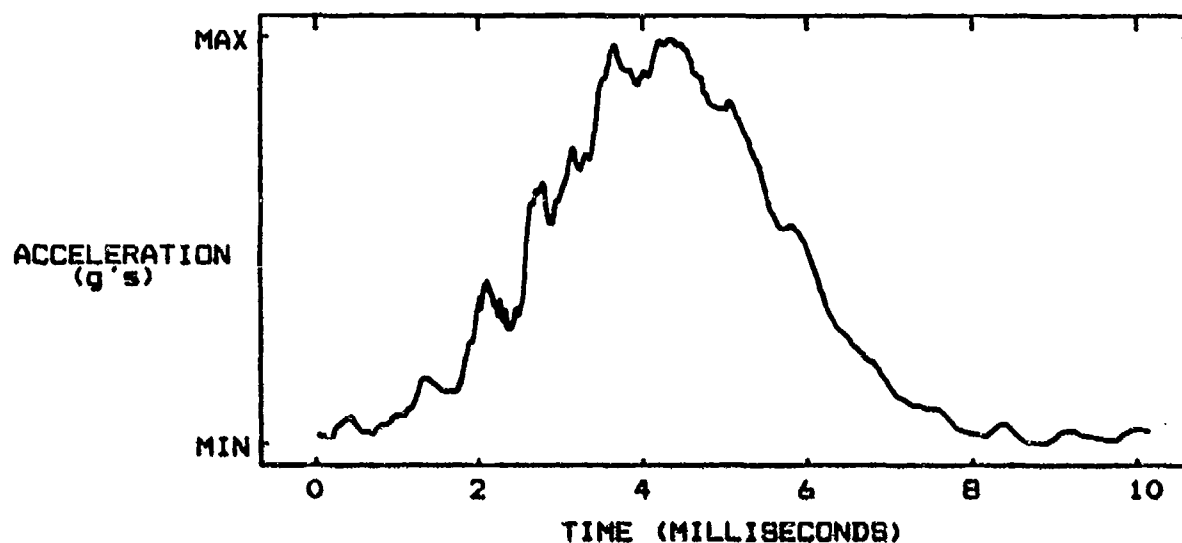
SPECIMEN I.D. 1-12A-5

THICKNESS .045 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

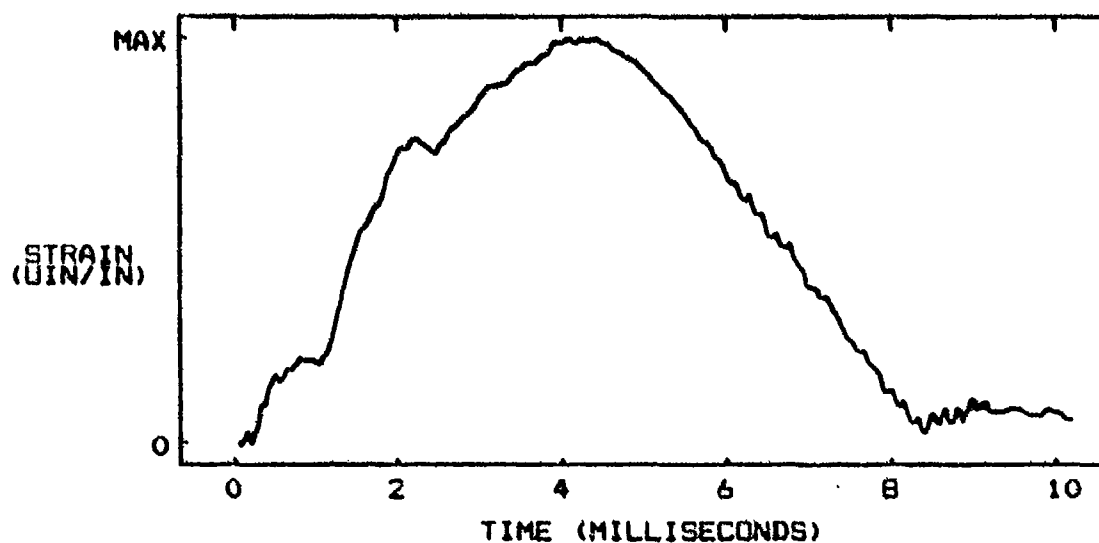
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -4.0 g's      MAXIMUM ACCELERATION 151 g's

INTEGRATED TOTAL VELOCITY 187.27 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 820 UIN/IN

Figure B-110. Panel 1-12A-5 Impact Response Data

# CSAI - IM6/3100

PANEL 1-12A-5 (ETW)

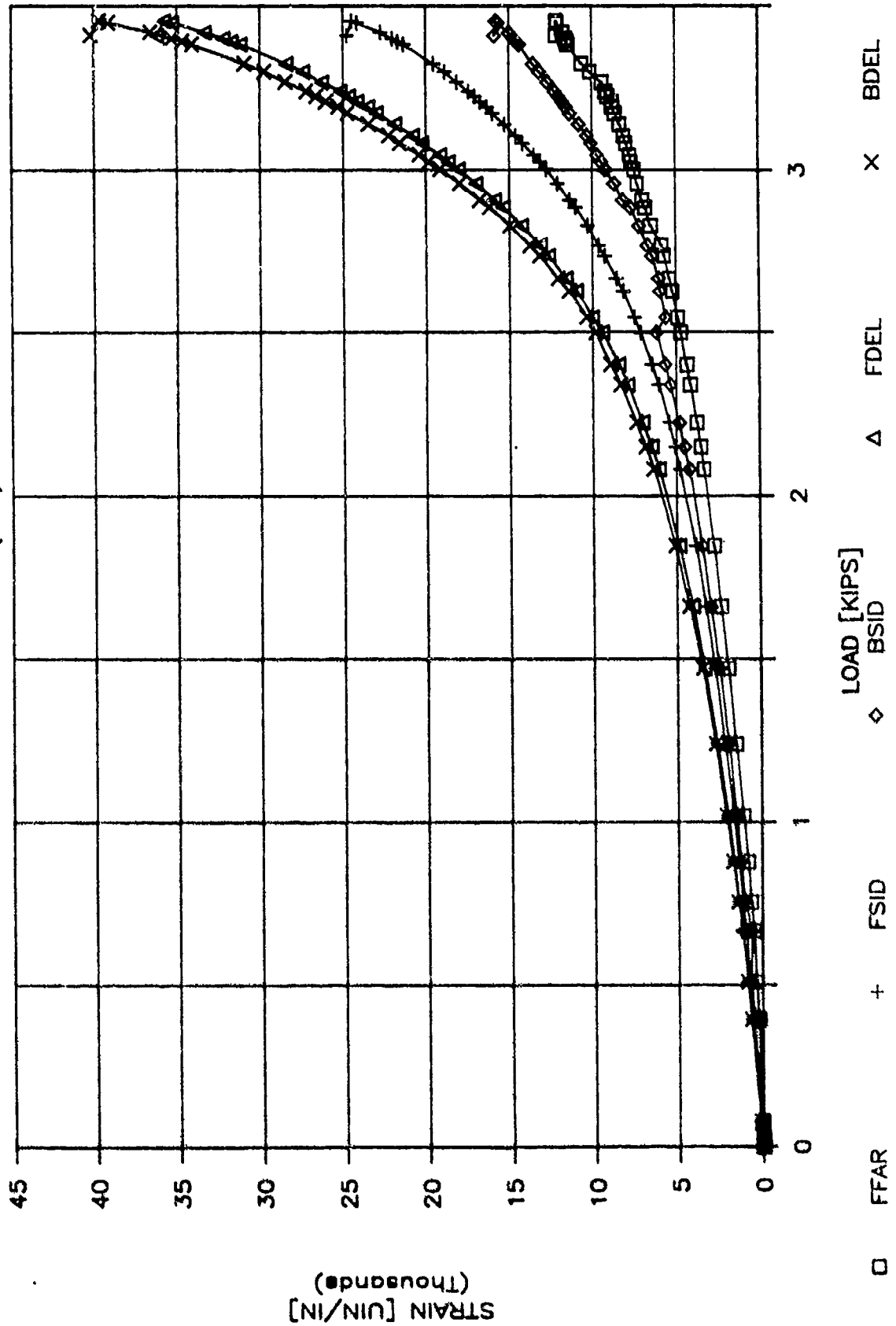


Figure B-111. Panel 1-12A-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

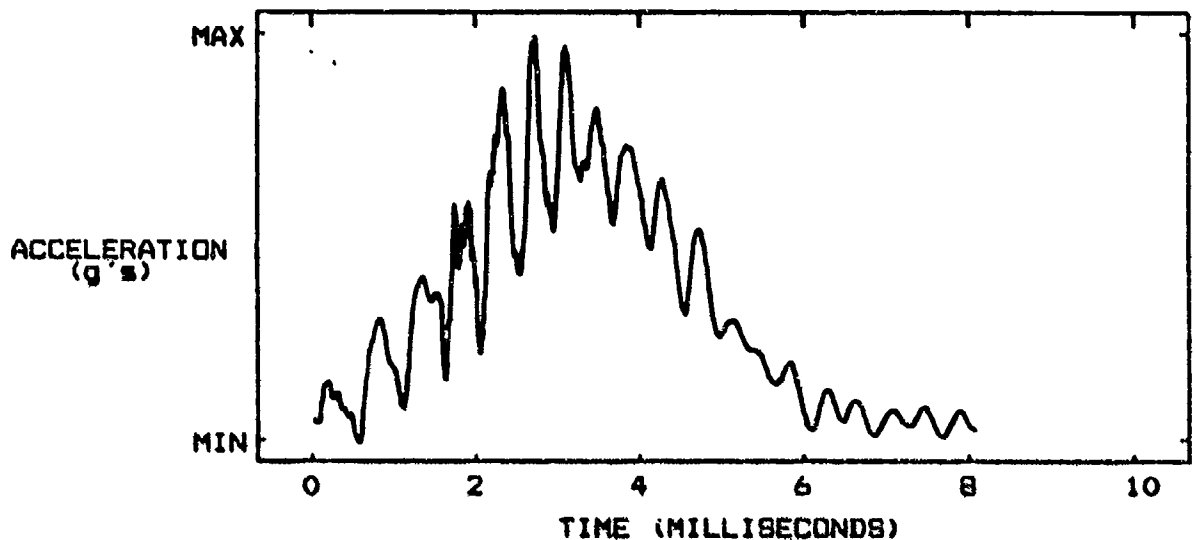
SPECIMEN I.D. 1-17-5

THICKNESS .069 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

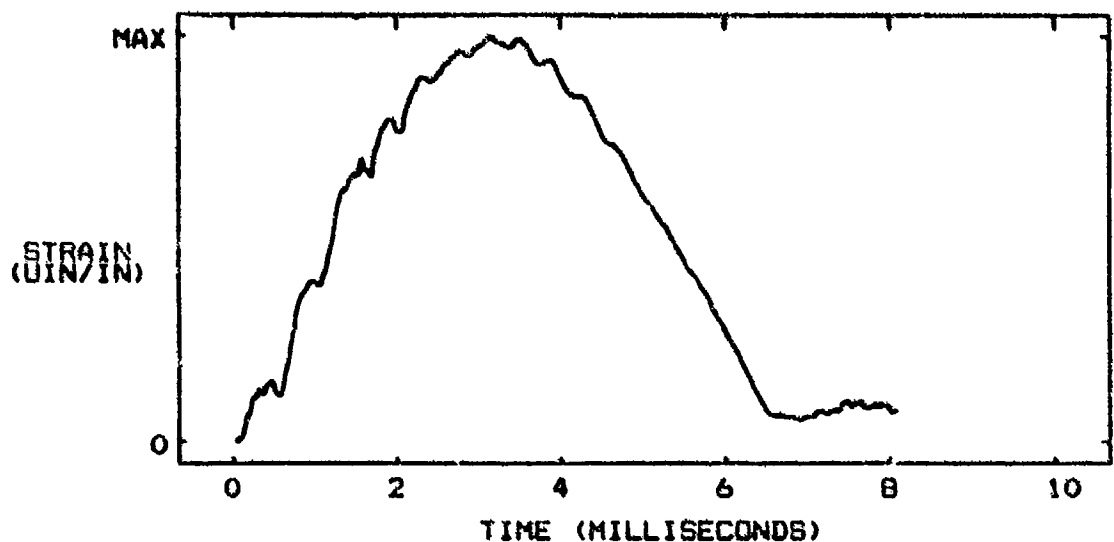
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -11.0 g's      MAXIMUM ACCELERATION 107.5 g's

INTEGRATED TOTAL VELOCITY 175.41 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1102 UIN/IN

Figure B-112. Panel 1-17-5 Impact Response Data

# CSAI — IM6/3100

PANEL 1-17-5 (ETW)

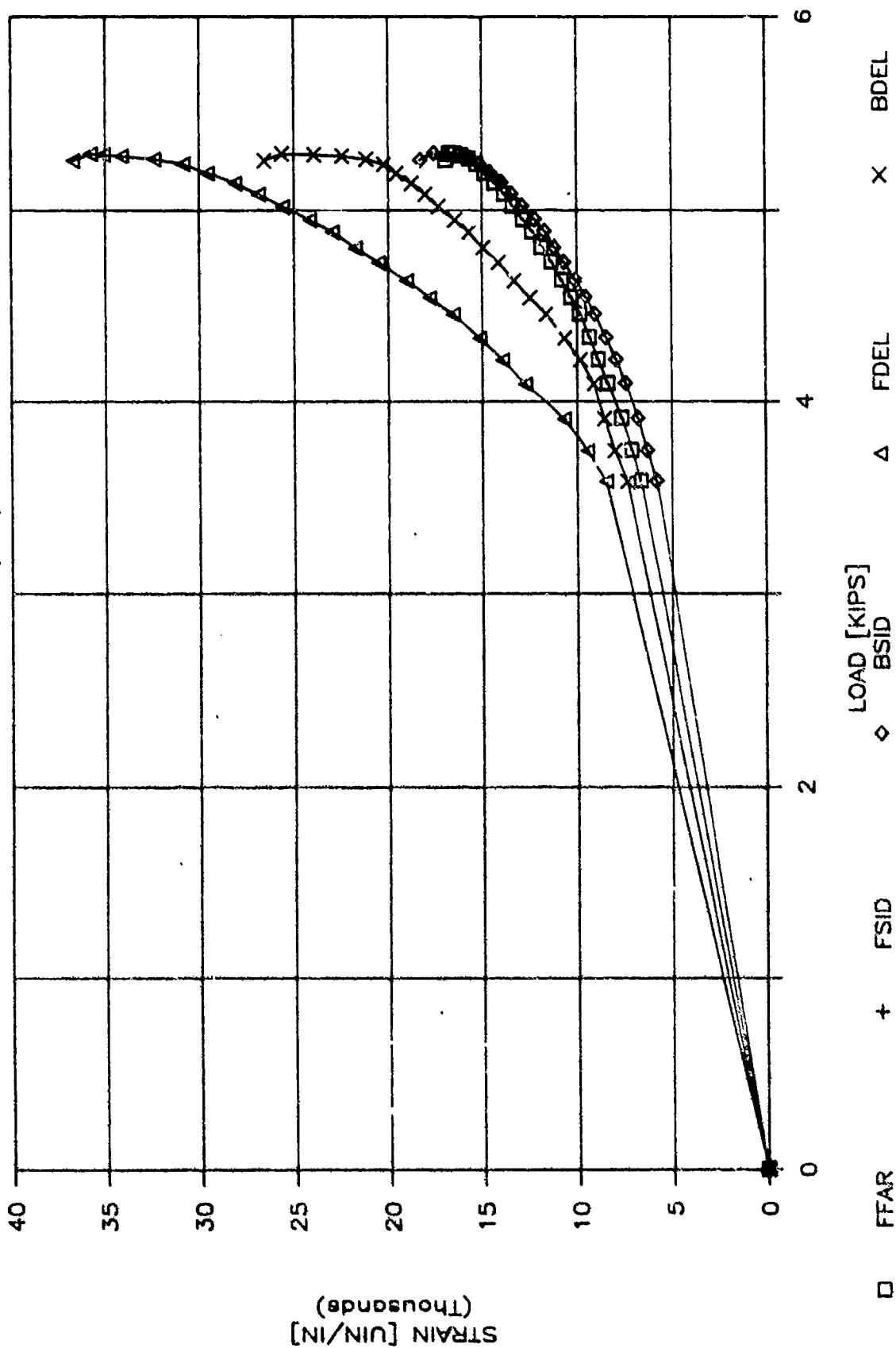


Figure B-113. Panel 1-17-5 Residual Compression Data

# LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

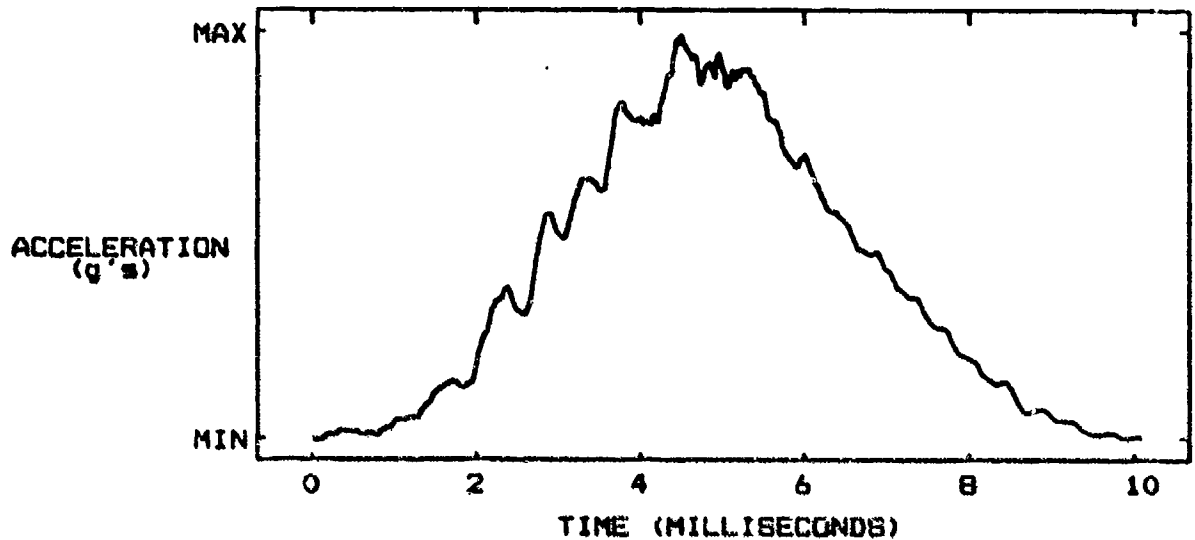
SPECIMEN I.D. 1-18-6

THICKNESS .025 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

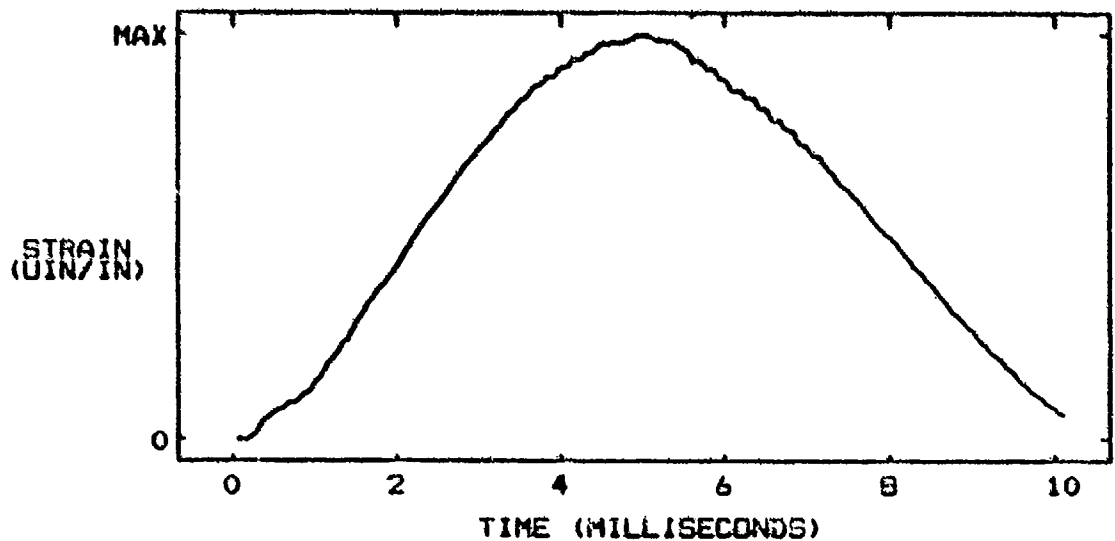
## ACCELERATION VERSUS TIME



MINIMUM ACCELERATION 0.0 g's      MAXIMUM ACCELERATION 108 g's

INTEGRATED TOTAL VELOCITY 159.68 IN/SEC

## PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1437 UIN/IN

Figure B-114. Panel 1-18-6 Impact Response Data

# CSAI - IM6/3100

PANEL 1-18-6 (ETW)

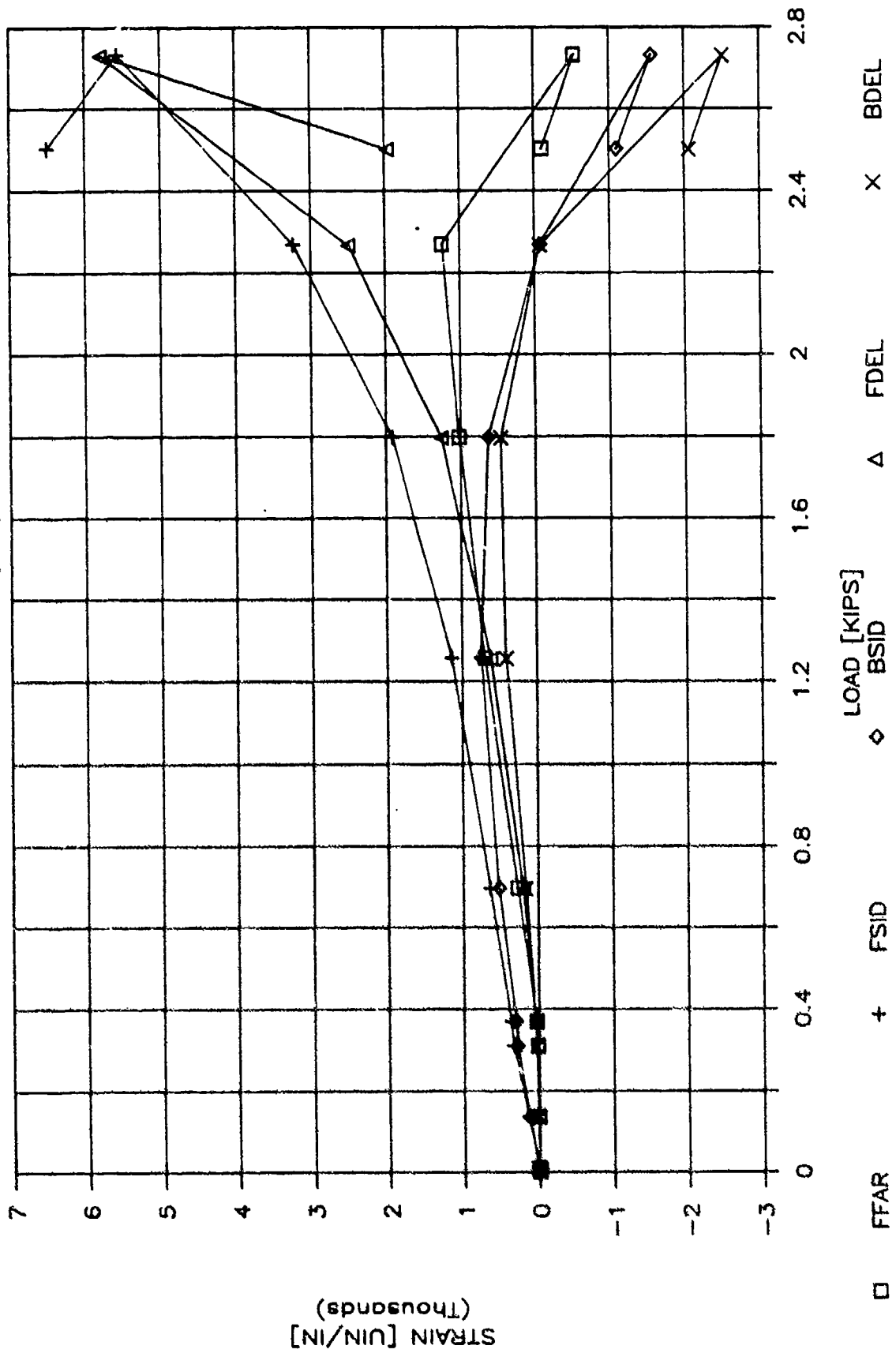


Figure B-115. Panel 1-18-6 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

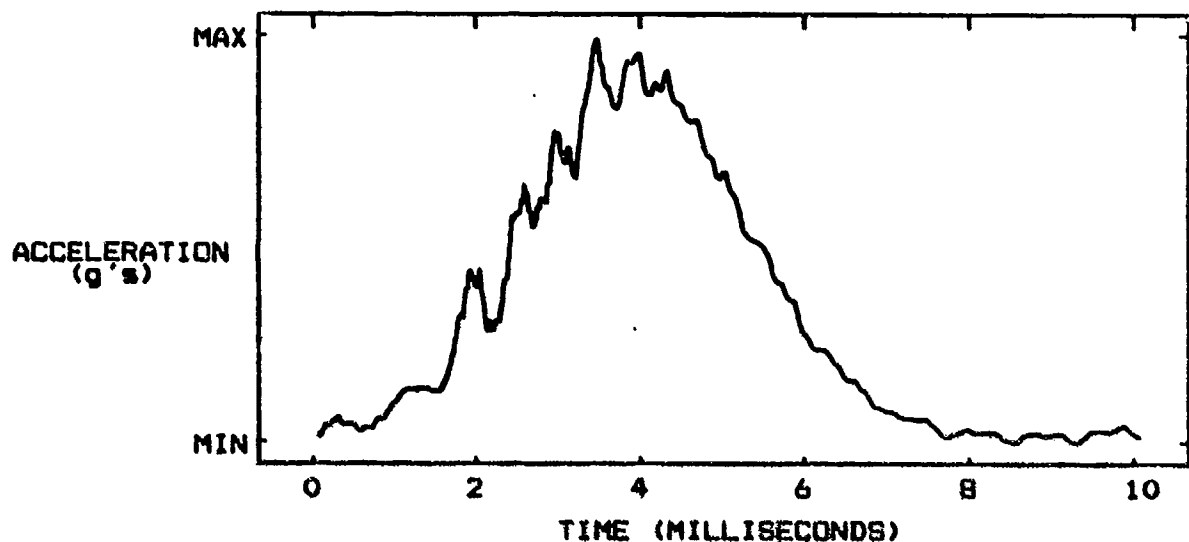
SPECIMEN I.D. 1-14A-4

THICKNESS .046 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

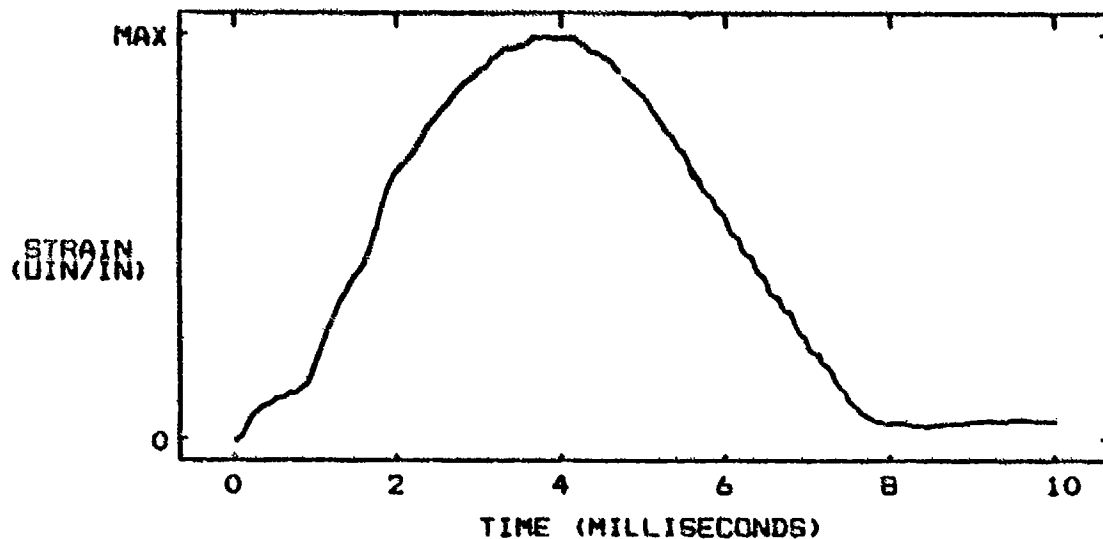
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -4.0 g's      MAXIMUM ACCELERATION 160 g's

INTEGRATED TOTAL VELOCITY 183.45 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1516 UIN/IN

Figure D-116. Panel 1-14A-4 Impact Response Data

# CSA1 - IM6/3100

PANEL 1-14A-4 (ETW)

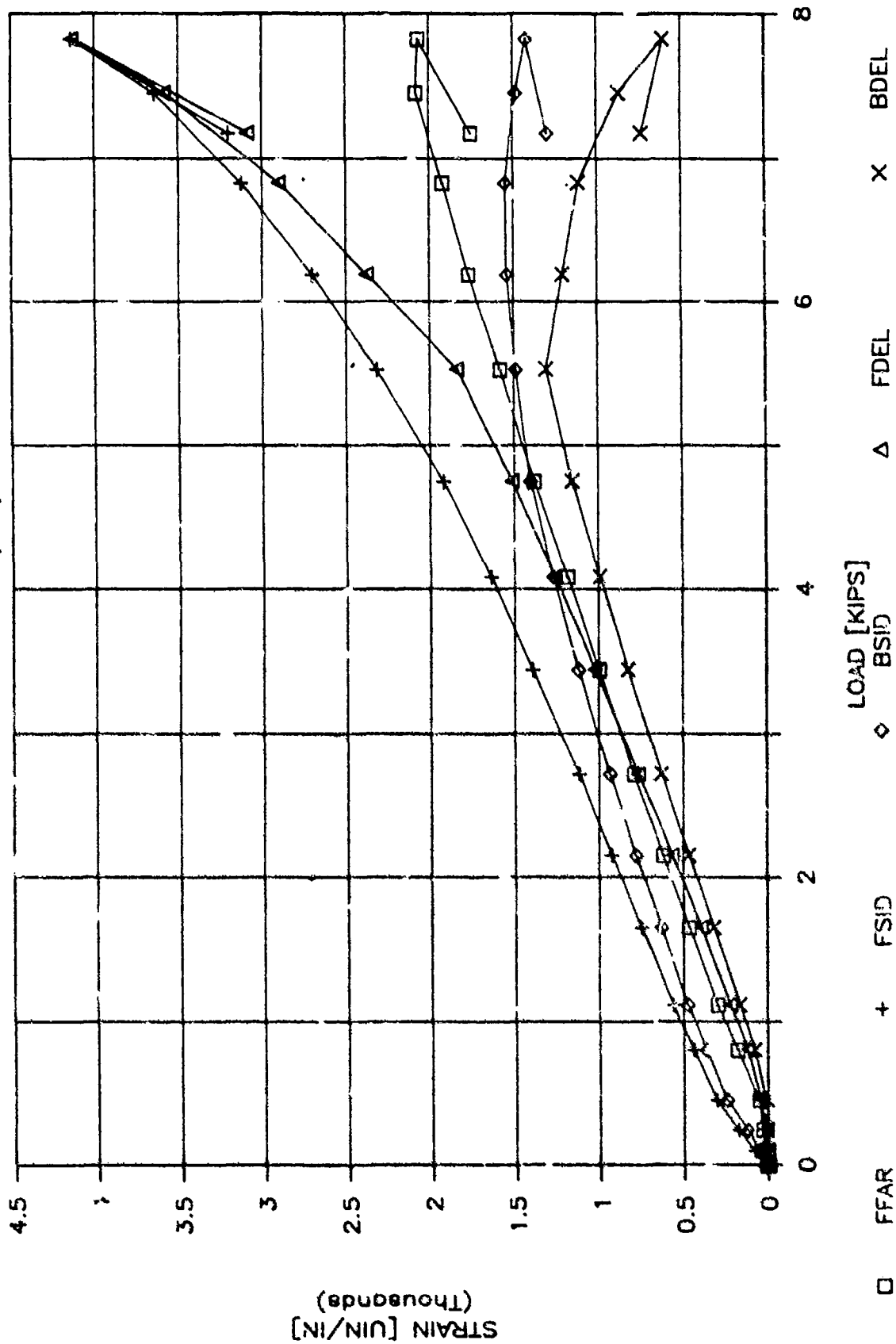


Figure B-117. Panel 1-14A-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

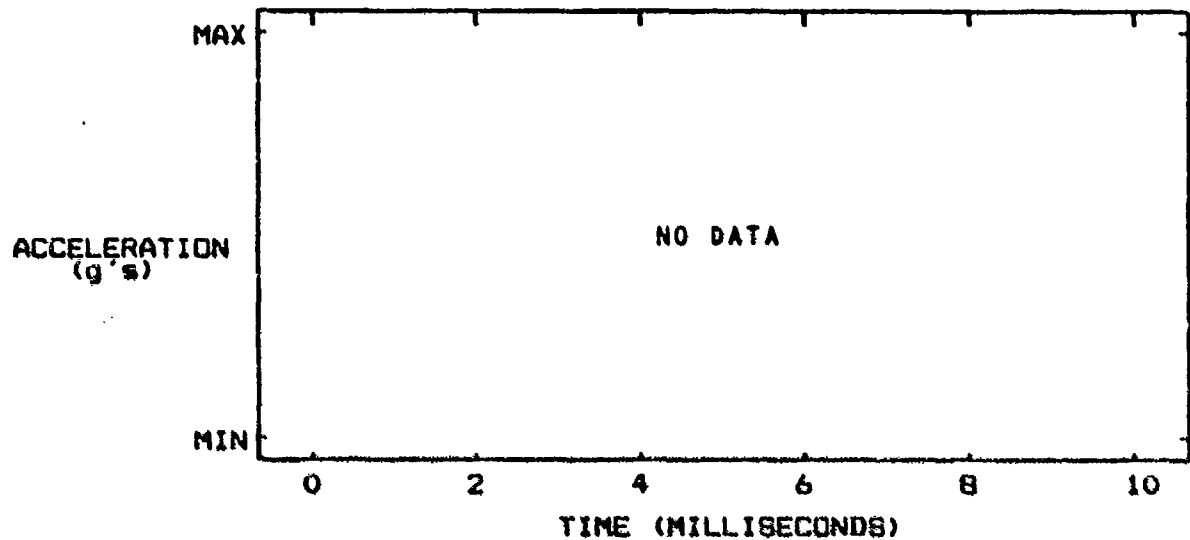
SPECIMEN I.D. 1-19-5.1

THICKNESS .065 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

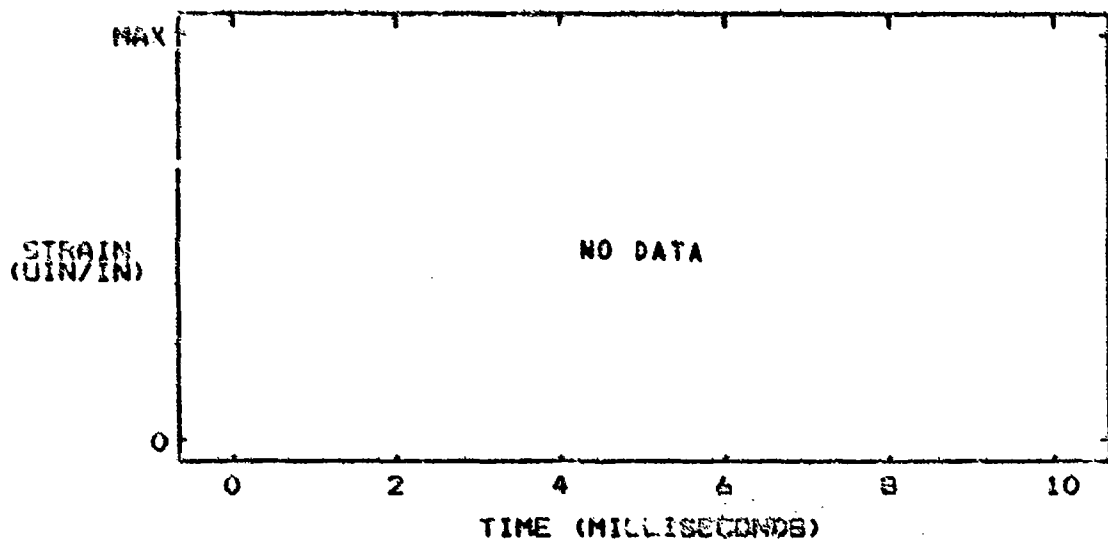
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION \_\_\_\_\_ g's      MAXIMUM ACCELERATION \_\_\_\_\_ g's

INTEGRATED TOTAL VELOCITY \_\_\_\_\_ IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN \_\_\_\_\_ UIN/IN

Figure B-118. Panel 1-19-5 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

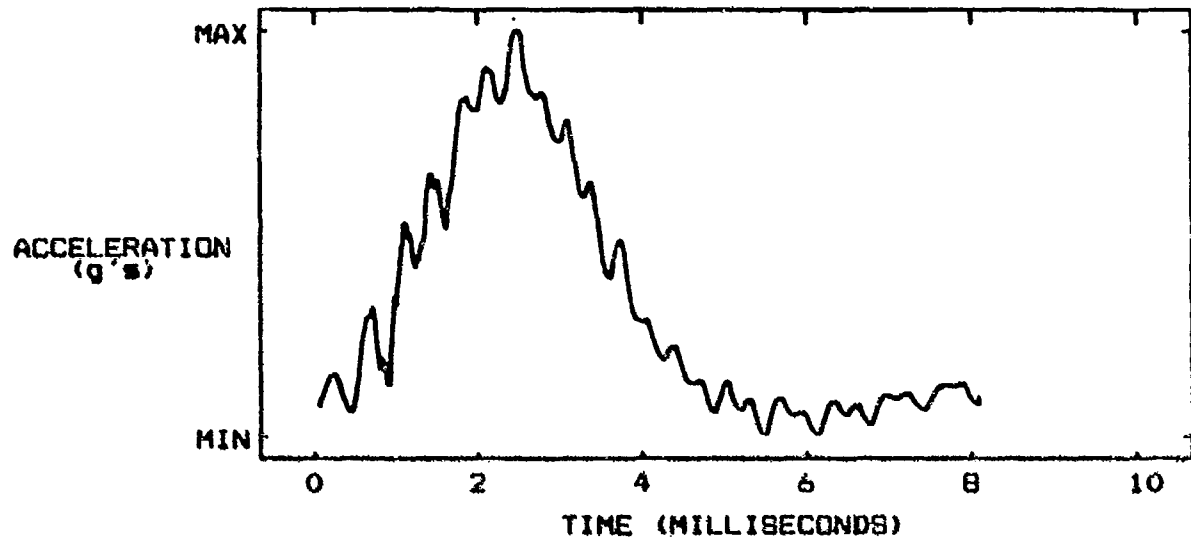
SPECIMEN I.D. 1-19-5.2

THICKNESS .065 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

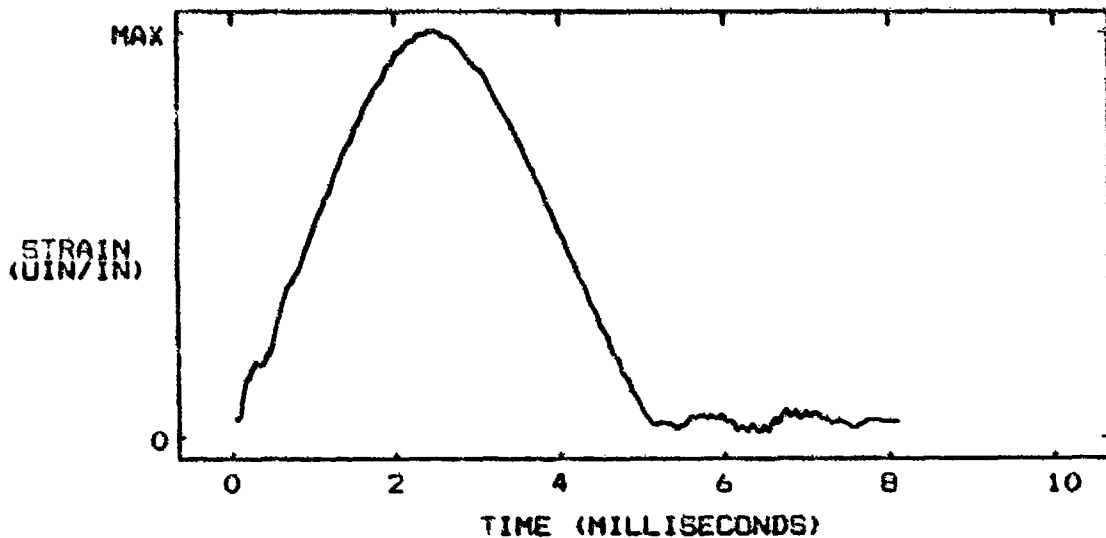
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -12.0 g's      MAXIMUM ACCELERATION 147 g's

INTEGRATED TOTAL VELOCITY 146.31 IN/SEC

### PANEL STRAIN VERSUS TIME

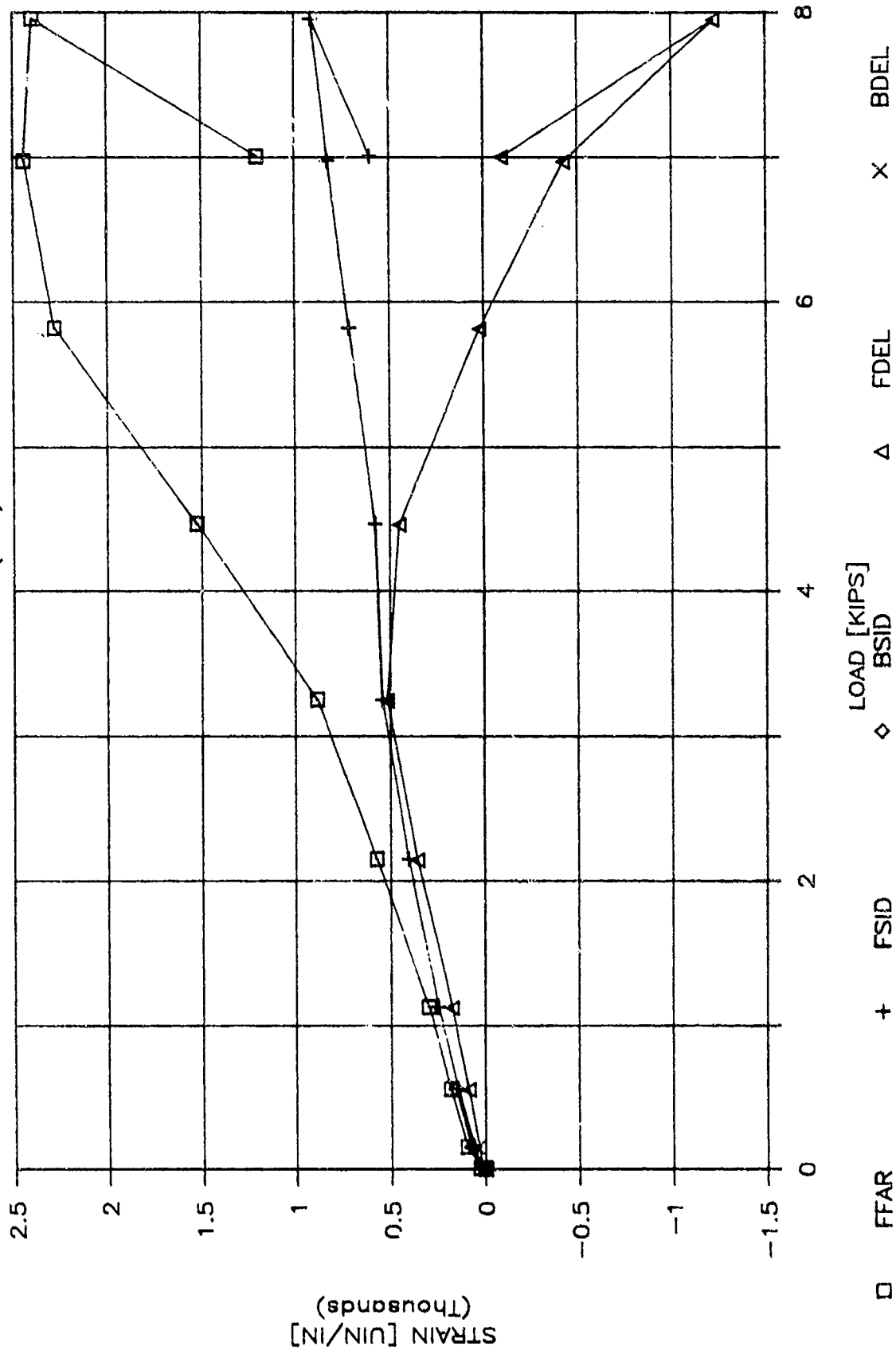


MAXIMUM STRAIN 1041 UIN/IN

Figure B-119. Panel 1-19-5 Second Impact Response Data

# CSAI — IM6/3100

PANEL 1-19-5 (ETW)



## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

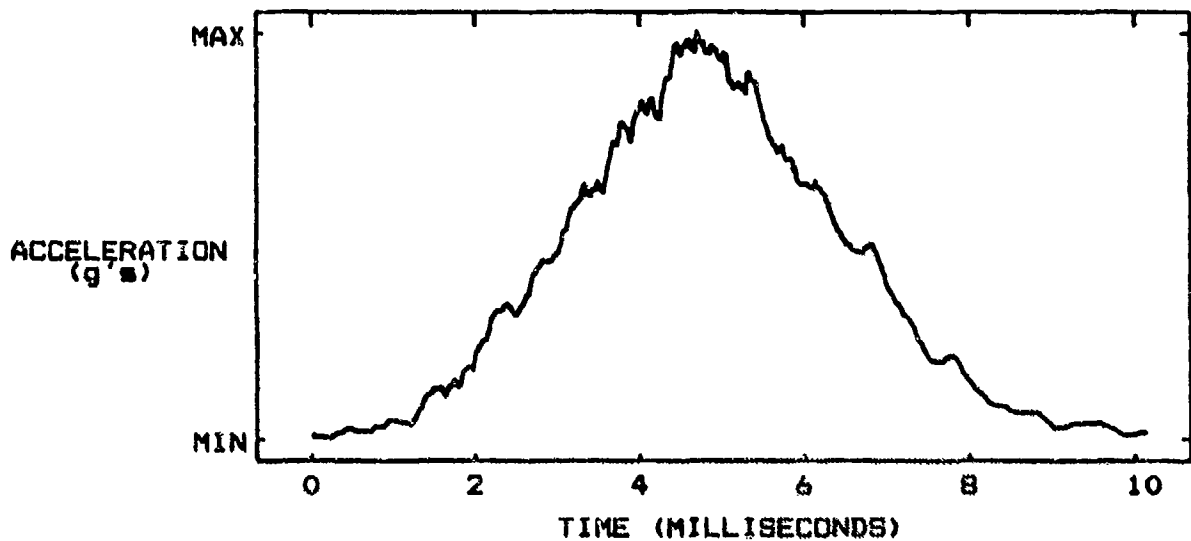
SPECIMEN I.D. 2-16-5

THICKNESS .022 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

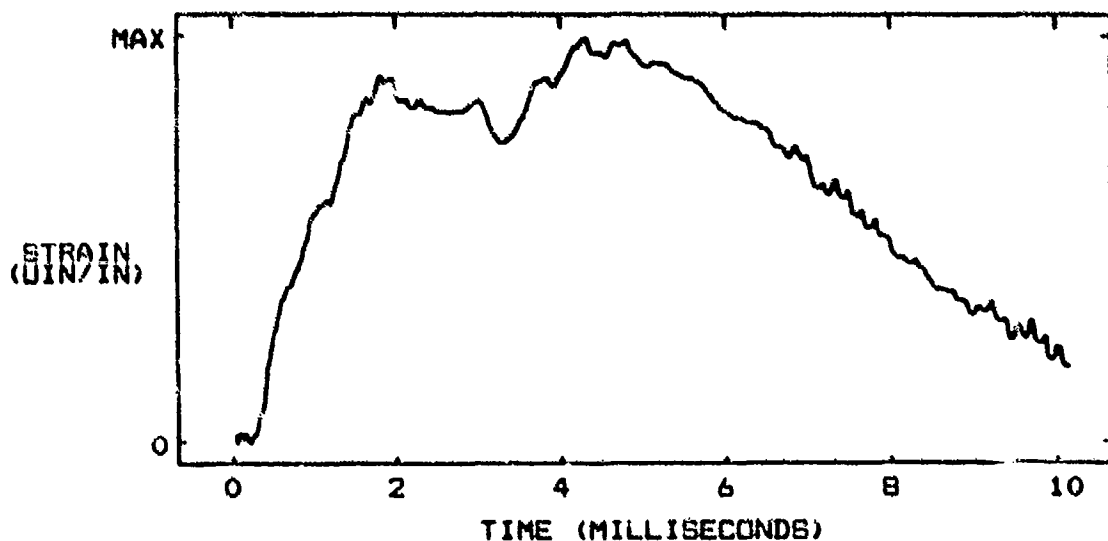
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION 0.0 g's      MAXIMUM ACCELERATION 98 g's

INTEGRATED TOTAL VELOCITY 135.15 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 314 IN/IN

Figure 8-121. Panel 2-16-5 Impact Response Data

# CSAI — IM6/F650

PANEL 2-16-5 (ETW)

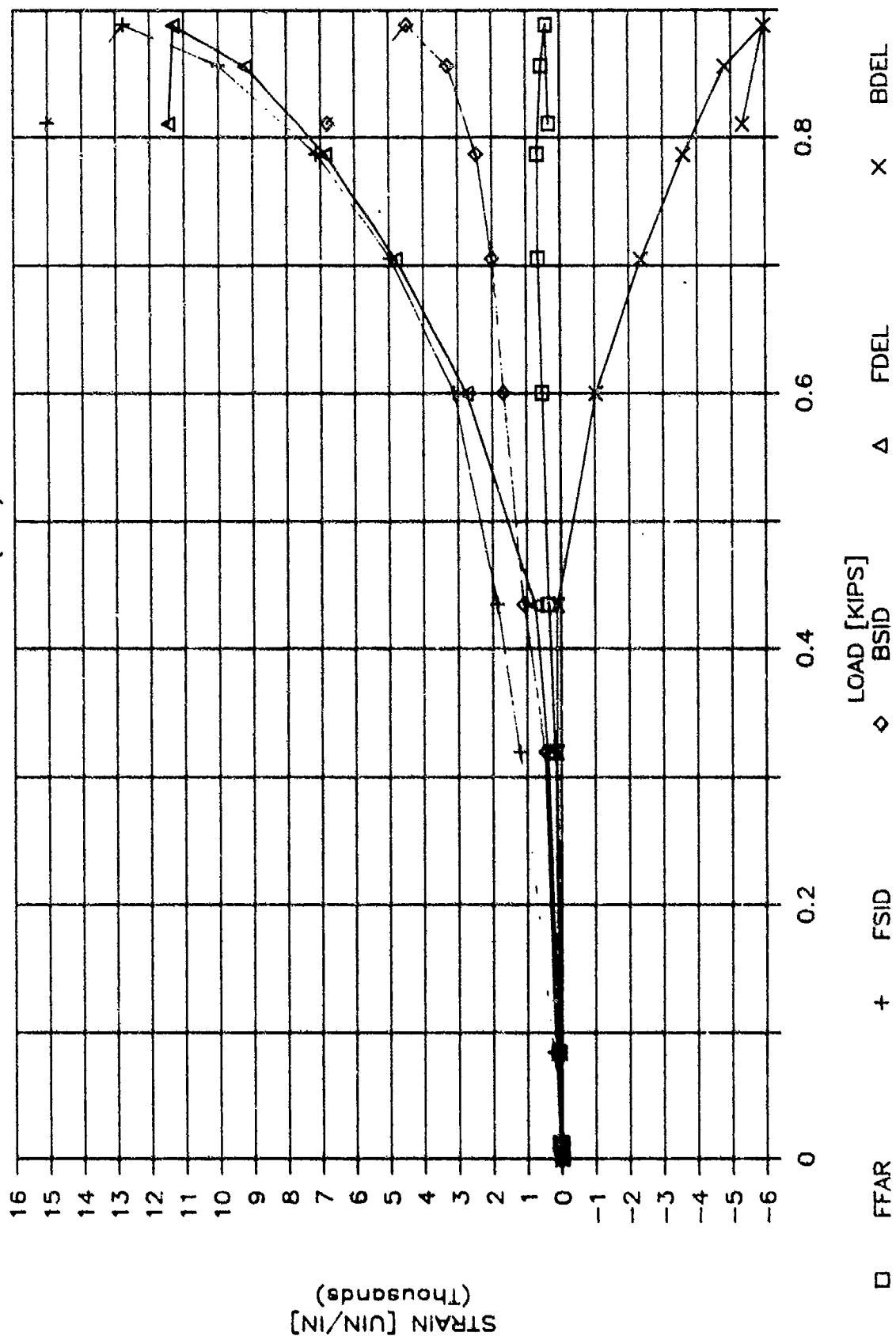


Figure B-122. Panel 2-16-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

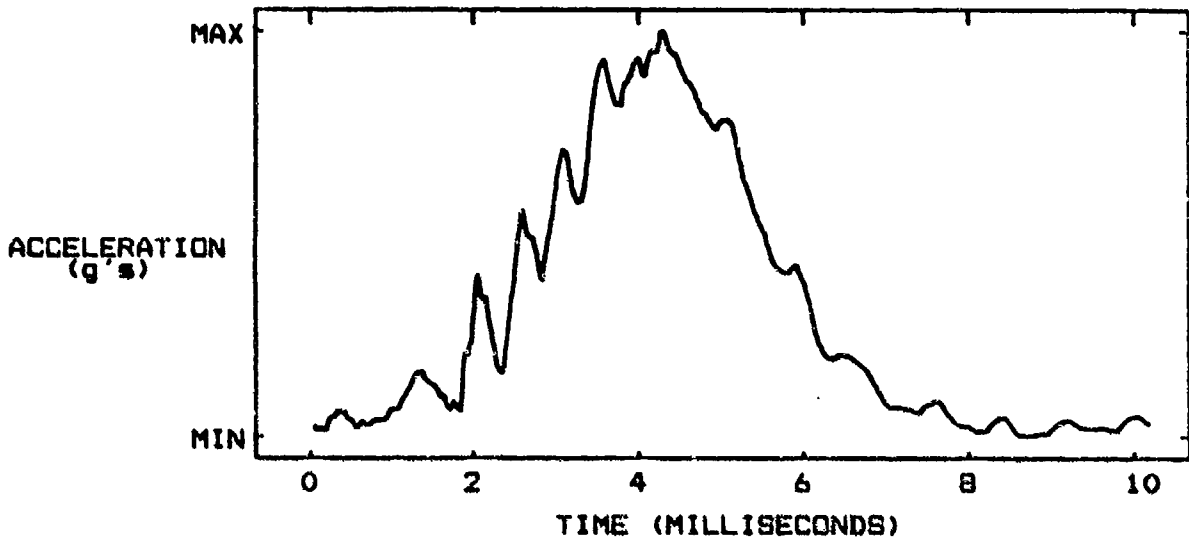
SPECIMEN I.D. 2-12A-4

THICKNESS .043 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

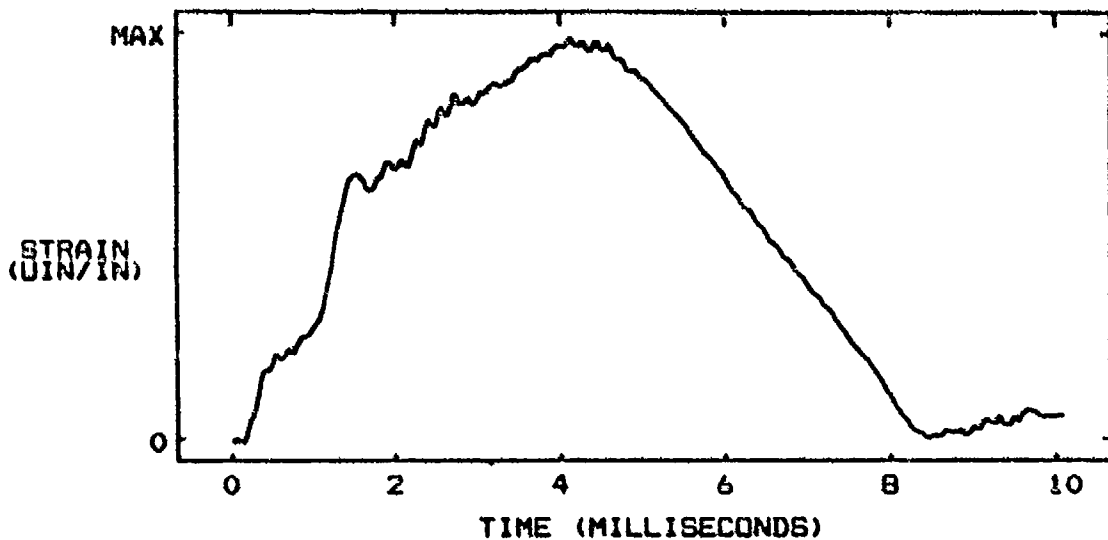
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -3.0 g's      MAXIMUM ACCELERATION 140 g's

INTEGRATED TOTAL VELOCITY 154.29 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 792 IN/IN

Figure B-123. Panel 2-12A-4 Impact Response Data

# CSAI — IM6/F650

PANEL 2-12A-4 (ETW)

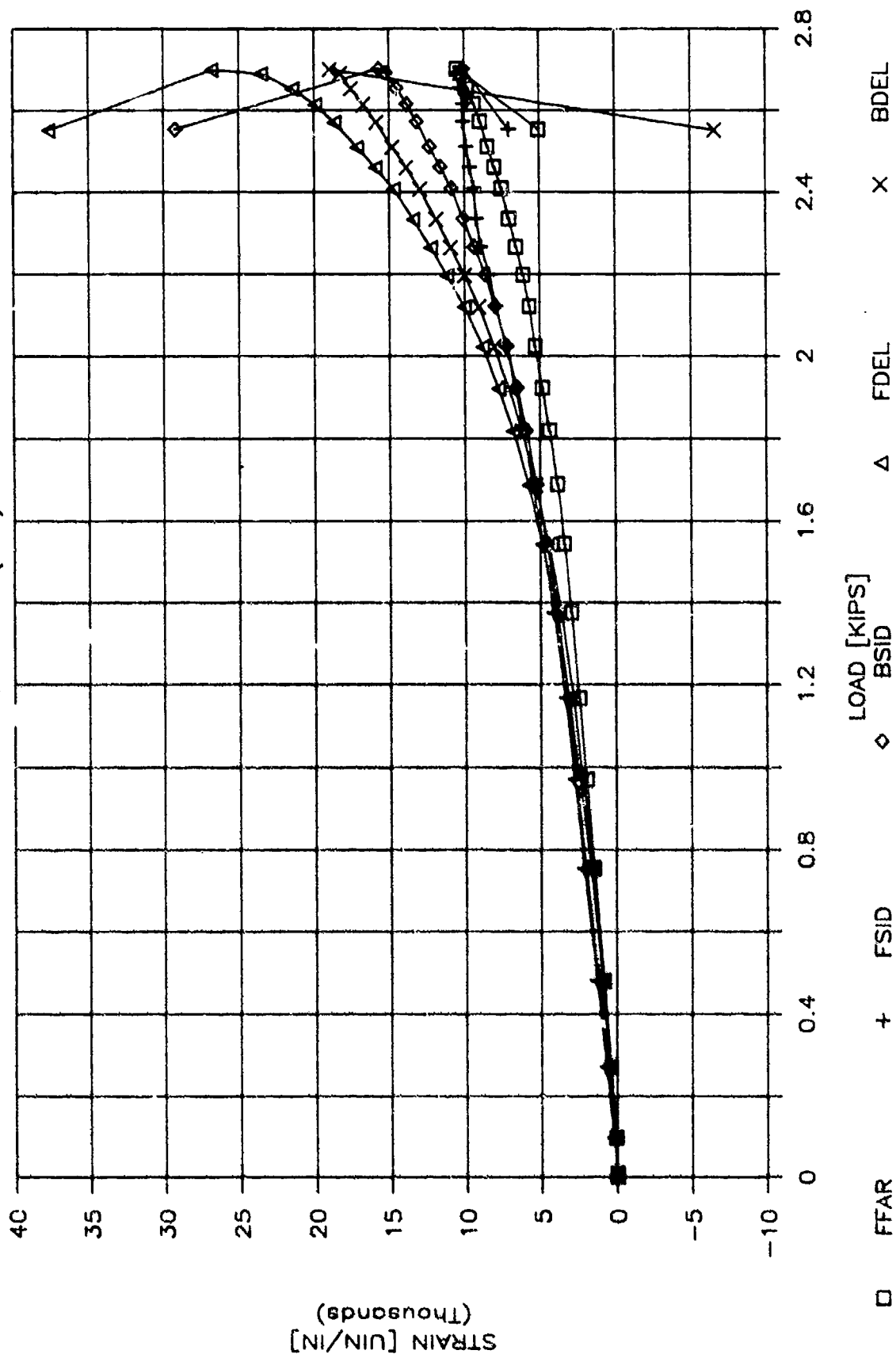


Figure B-124. Panel 2-12A-4 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

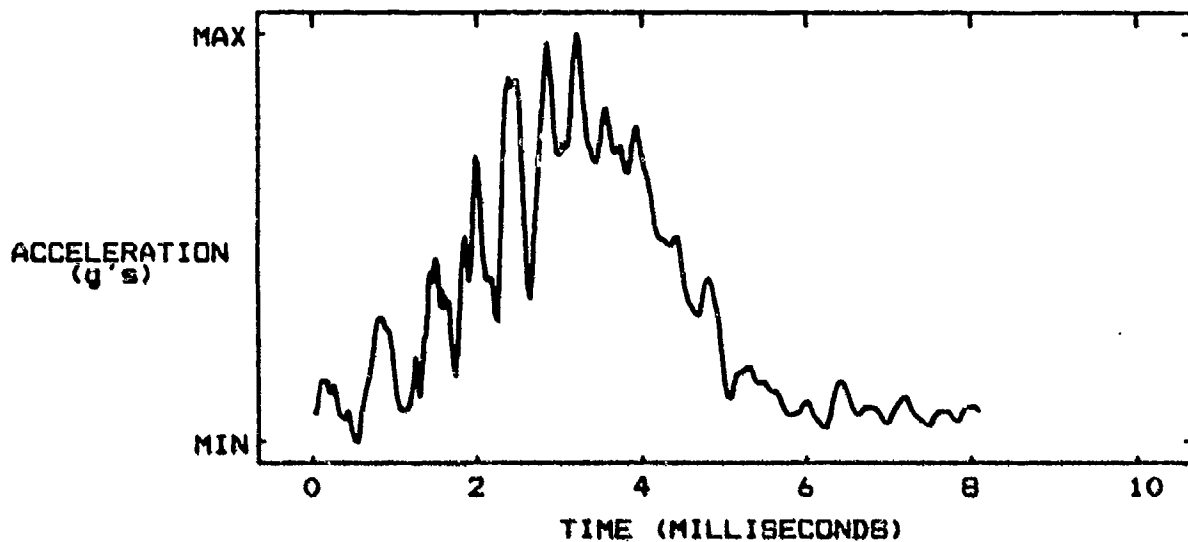
SPECIMEN I.D. 2-17-6

THICKNESS .064 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

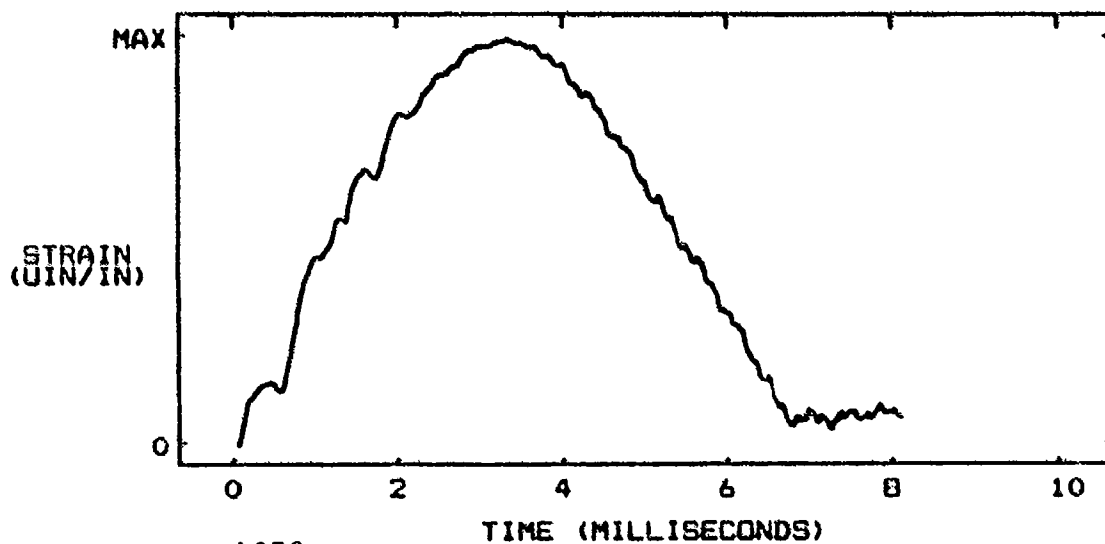
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -13.0 g's      MAXIMUM ACCELERATION 169 g's

INTEGRATED TOTAL VELOCITY 136.72 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1070 IN/IN

Figure B-125. Panel 2-17-6 Impact Response Data

# CSAI - IM6/F650

PANEL 2-17-6 (ETW)

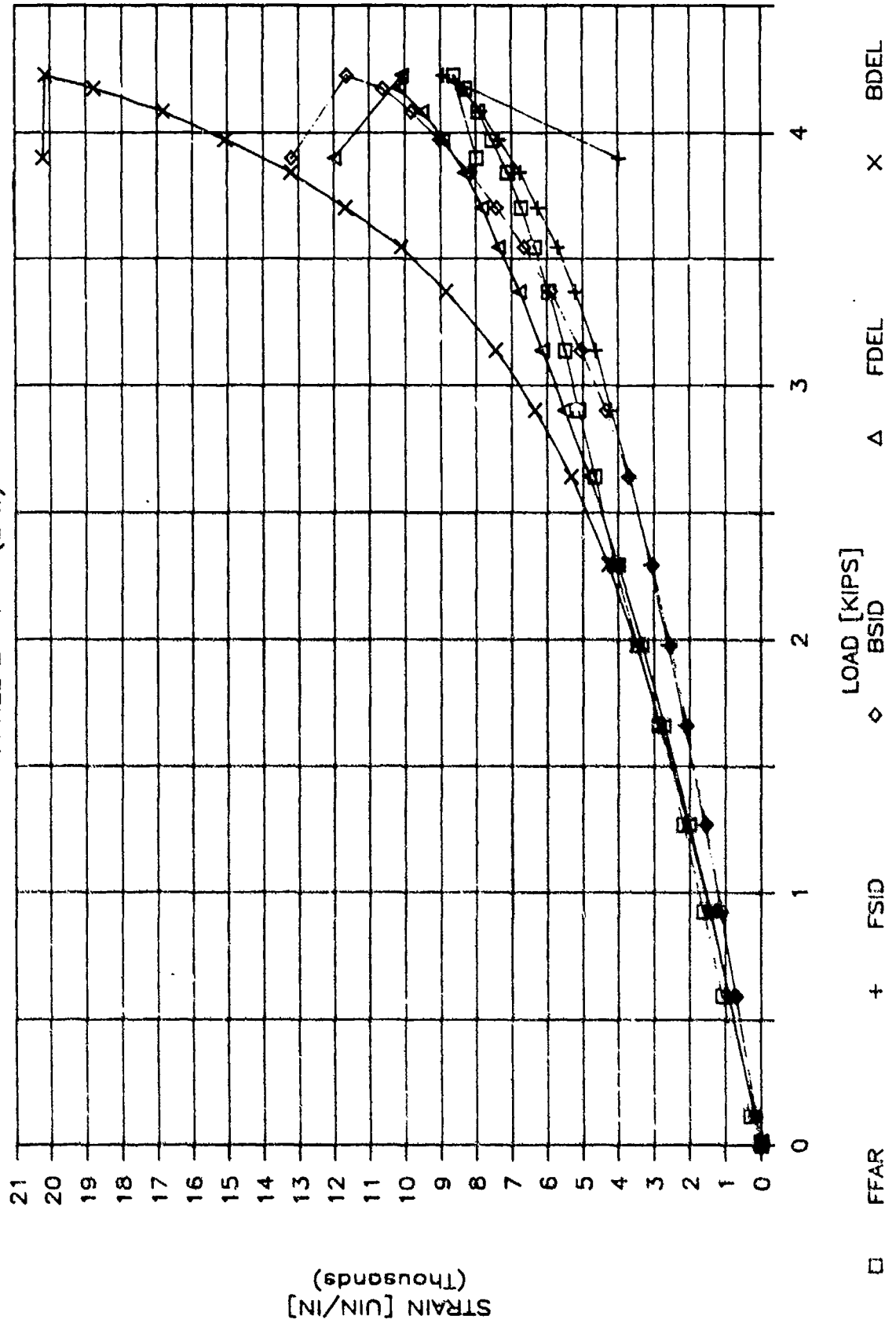


Figure B-126. Panel 2-17-6 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

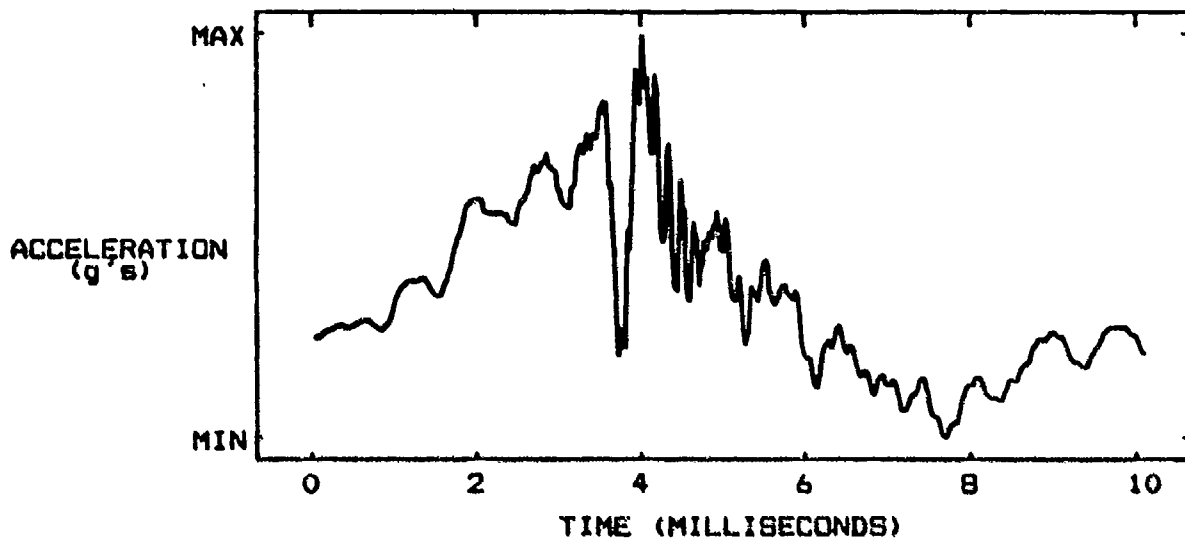
SPECIMEN I.D. 2-18-5

THICKNESS .022 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

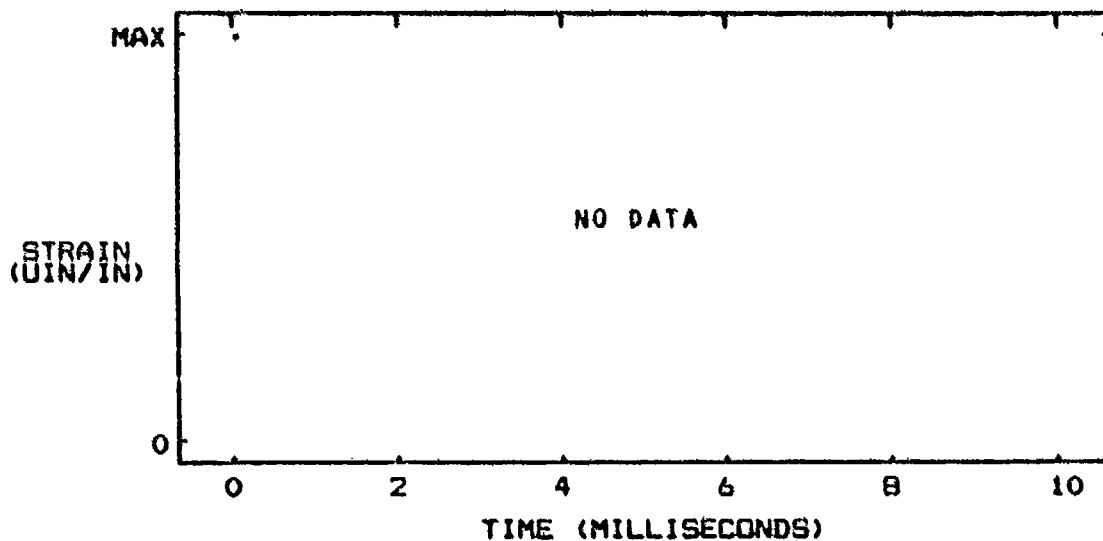
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -28.0 g's      MAXIMUM ACCELERATION 88 g's

INTEGRATED TOTAL VELOCITY 61.3 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1437 UIN/IN

Figure B-127. Panel 2-18-5 Impact Response Data

# CSA1 - IM6/F650

PANEL 2-18-5 (ETW)

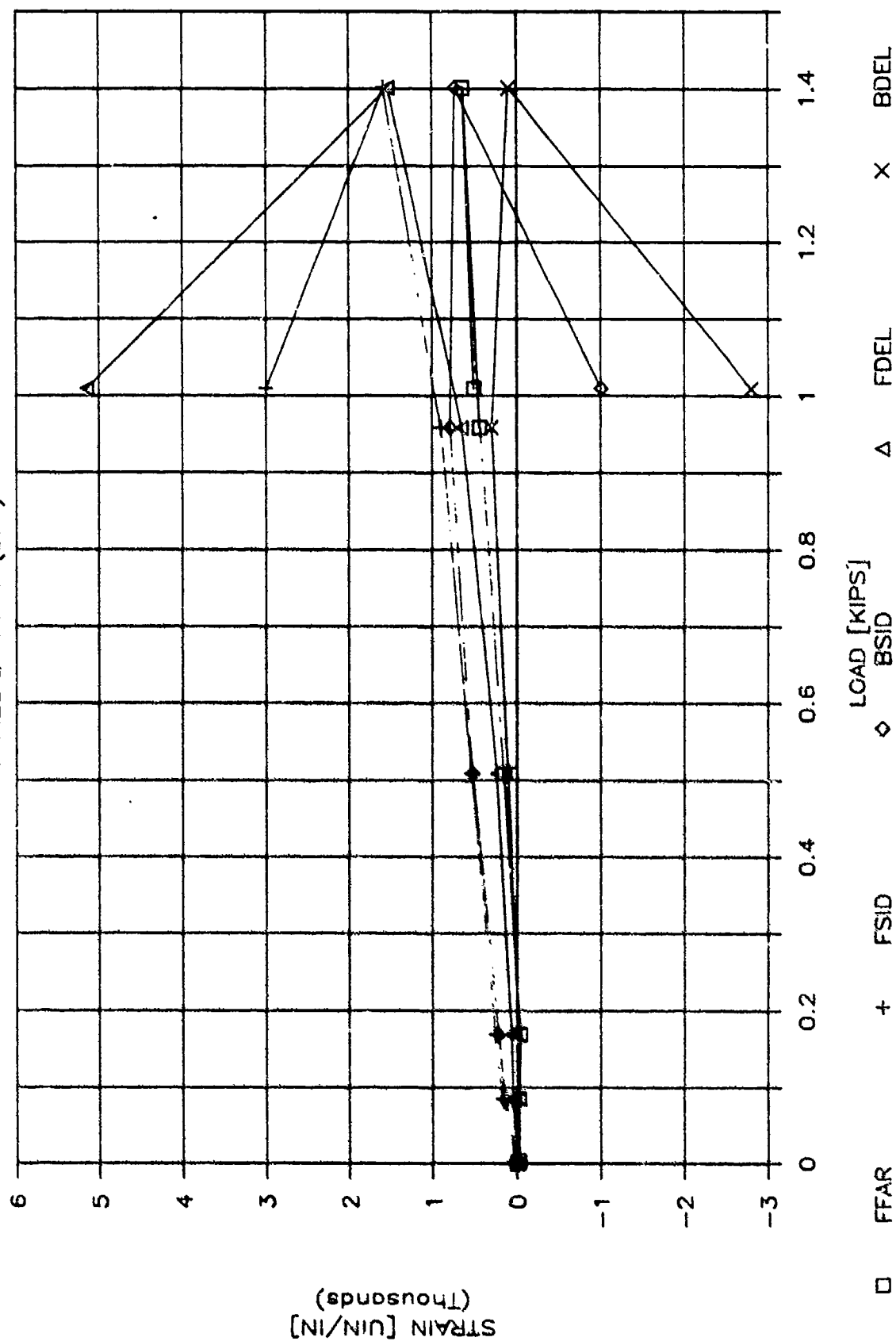


Figure B-128. Panel 2-18-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

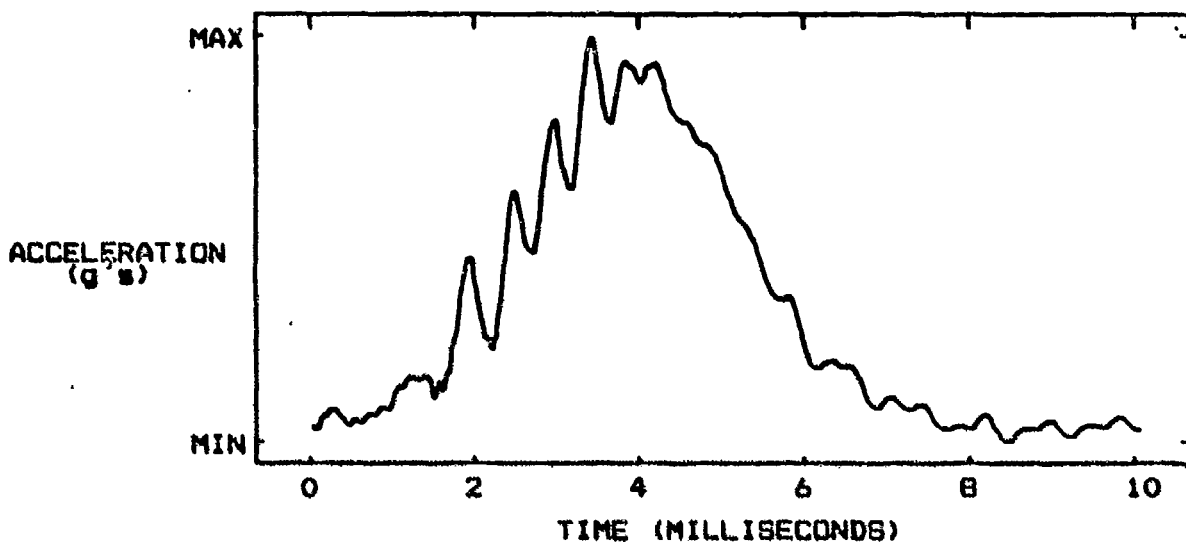
SPECIMEN I.D. 2-14A-5.1

THICKNESS .044 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

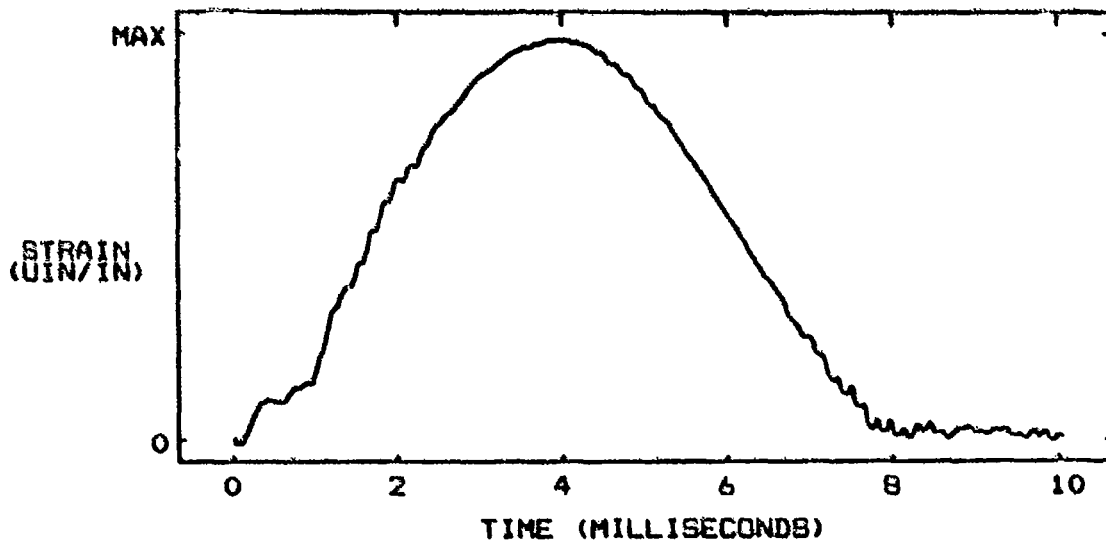
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -6.0 g's      MAXIMUM ACCELERATION 149 g's

INTEGRATED TOTAL VELOCITY 166.05 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1165 UIN/IN

Figure B-129. Panel 2-14A-5 First Impact Response Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

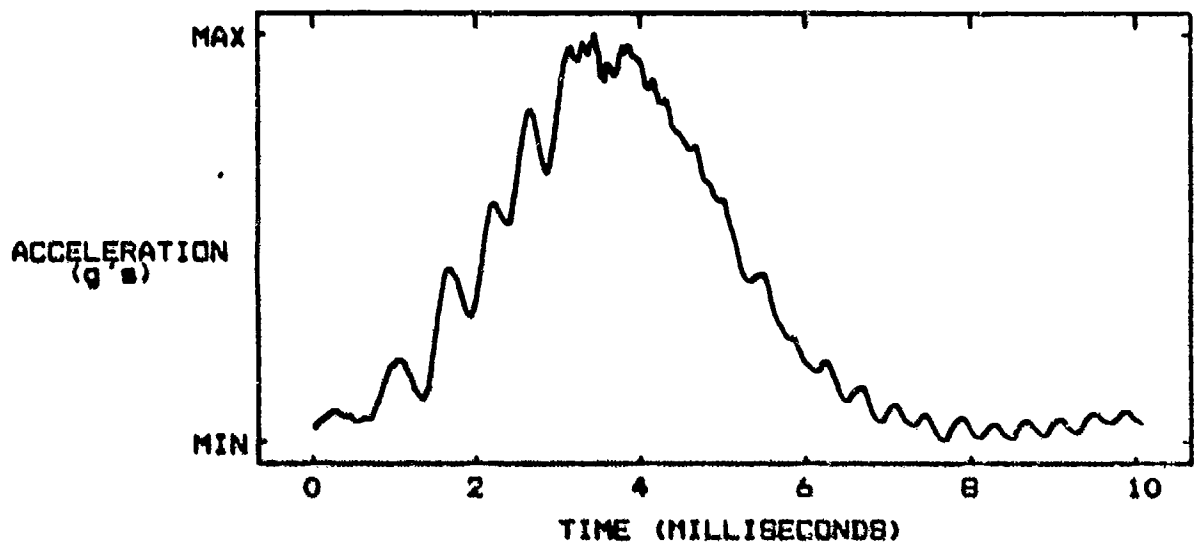
SPECIMEN I.D. 2-14A-5.2

THICKNESS .044 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

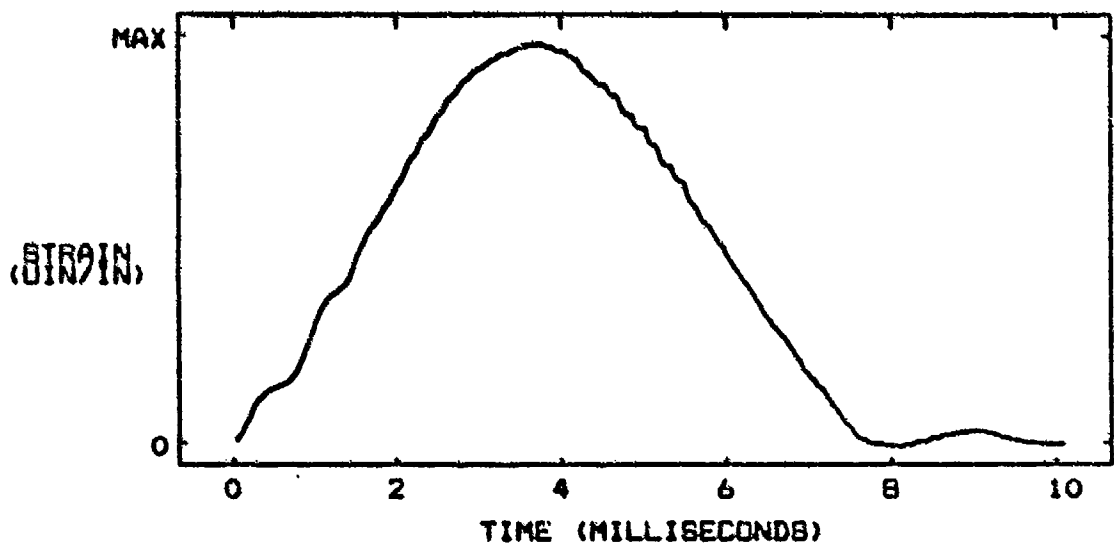
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -5.0 g's      MAXIMUM ACCELERATION 154 g's

INTEGRATED TOTAL VELOCITY 178.27 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1212  $\mu$ IN/IN

Figure B-130. Panel 2-14A-5 Second Impact Response Data

# CSAI - IM6/F650

PANEL 2-14A-5 (ETW)

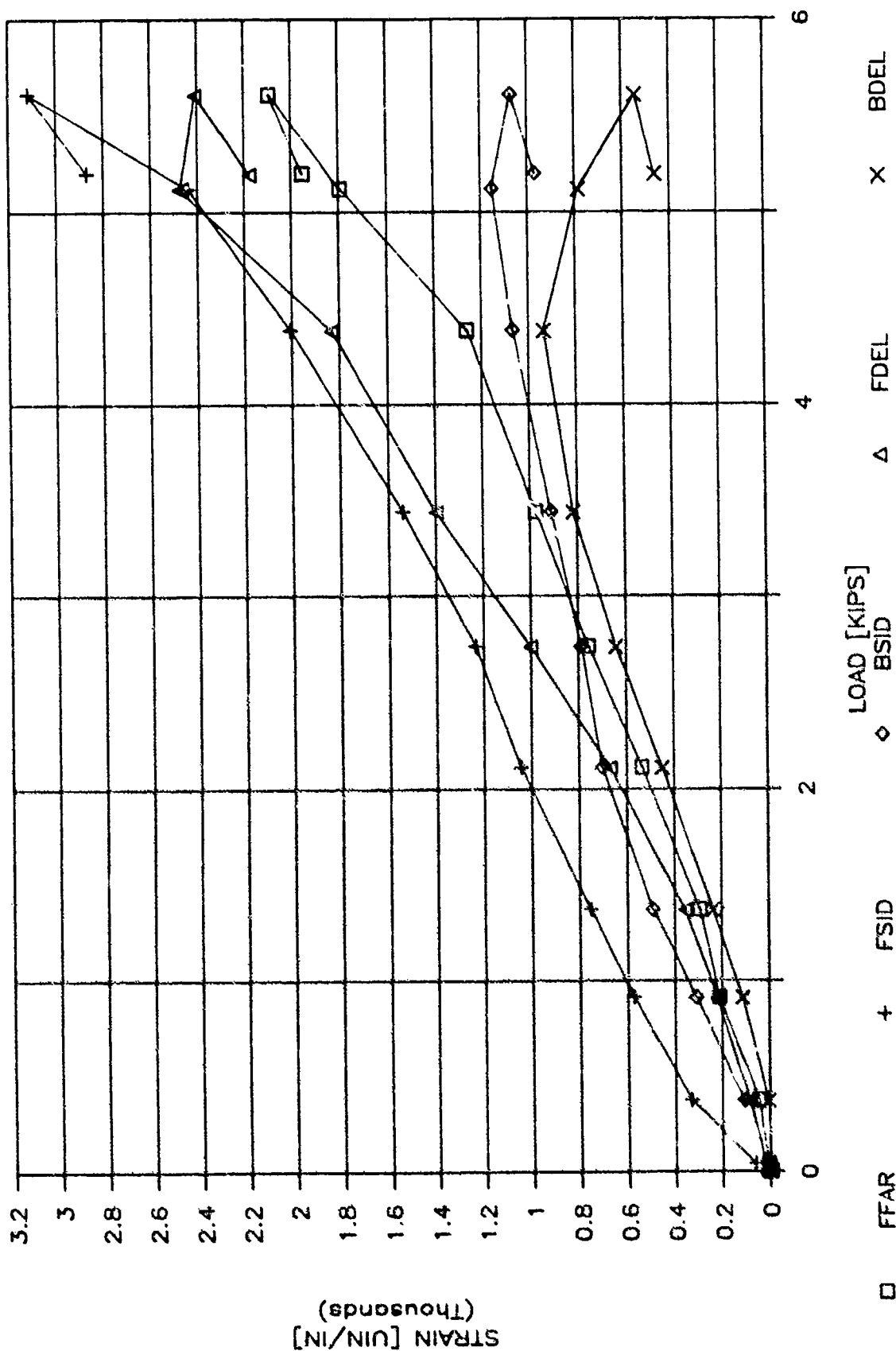


Figure B-131. Panel 2-14A-5 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

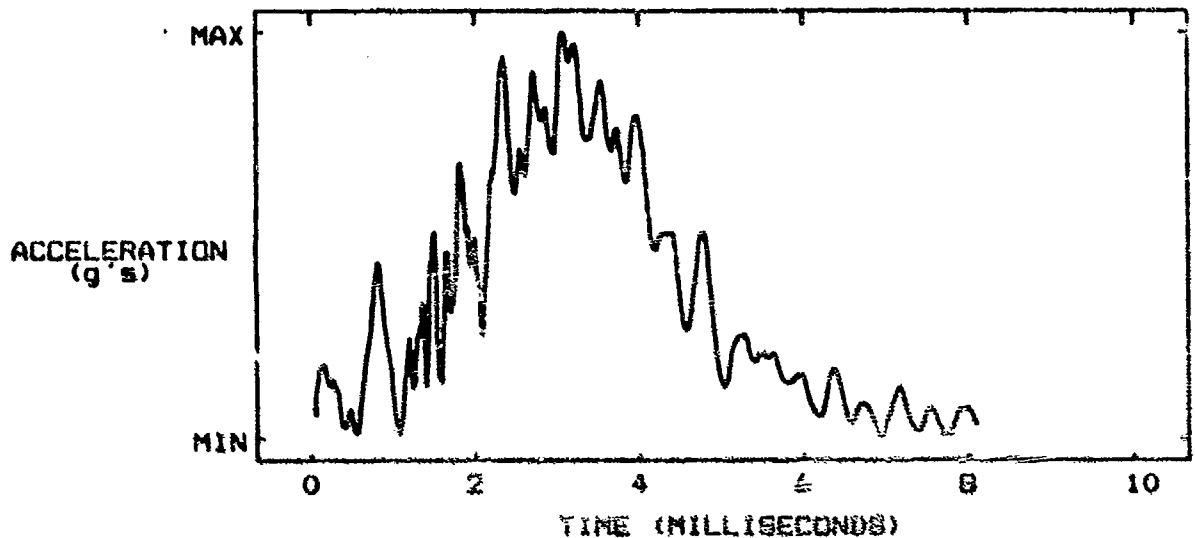
SPECIMEN I.D. 2-19-6

THICKNESS 0.62 IN

DROP CARRIAGE WT. 3.83 LBS

DROP HEIGHT 16.7 IN

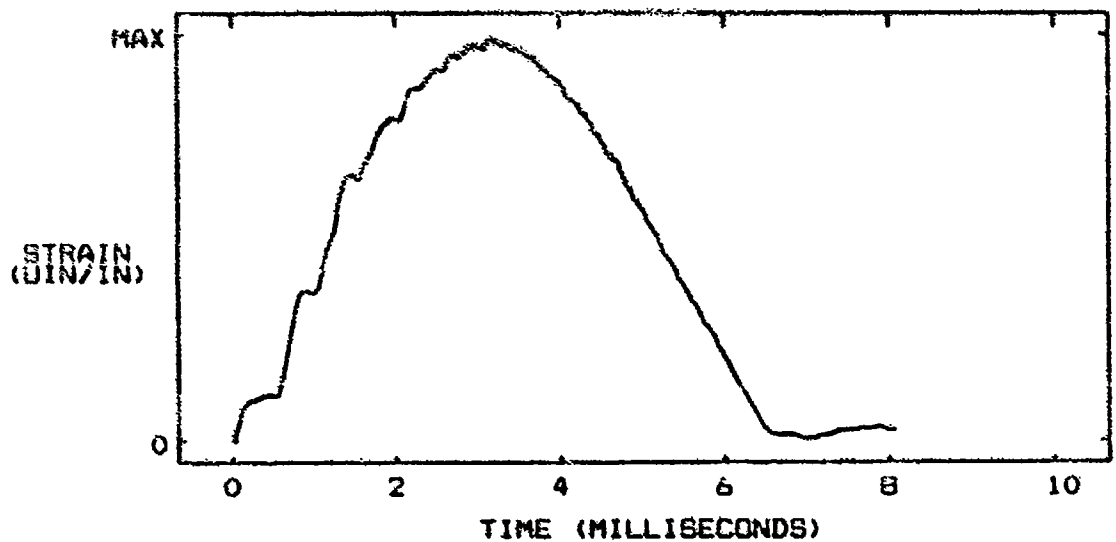
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -8.0 g's      MAXIMUM ACCELERATION 146 g's

INTEGRATED TOTAL VELOCITY 132.04 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 1110 UIN/IN

Figure B-132. Panel 2-19-6 Impact Response Data

# CSA1 - IM6/F650

PANEL 2-19-6 (ETW)

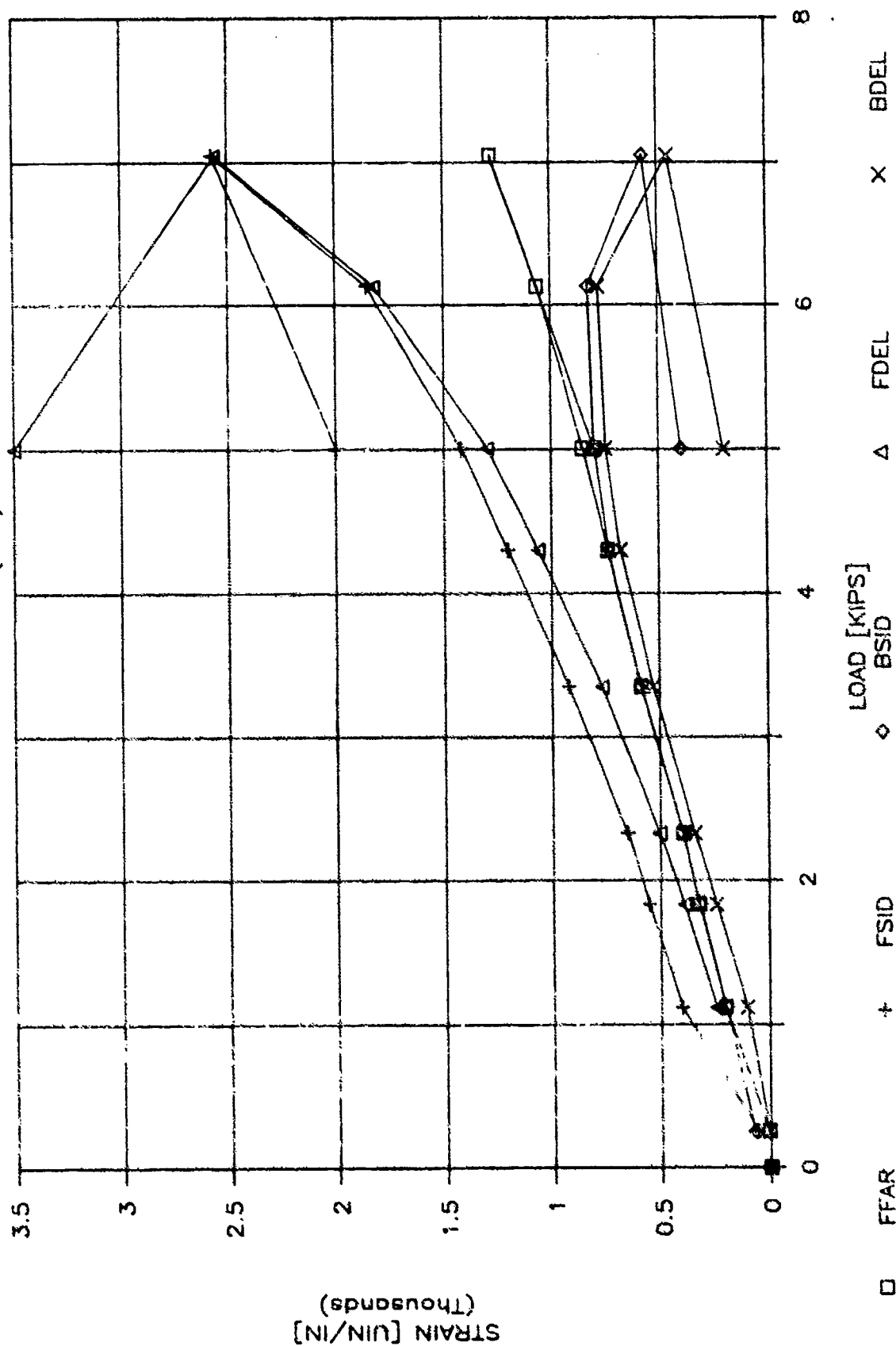


Figure B-133. Panel 2-19-6 Residual Compression Data

B.3 VISIBLE IMPACT DAMAGE

Material	Specimen Number	Layup	Thickness (in.)	Impact Weight (lb)	Nominal Impact Energy (ft-lb)	Potential Impact Energy (ft-lb)	Kinetic Impact Energy (ft-lb)	G <sub>max</sub>	ε <sub>max</sub> (μin./in.)	Dent Depth (in.)	Delamination Width (in.)	Residual Strength (ksi)	Residual Strain (μin./in.)
RTD													
IM6/3100	1-12-8	10/80/10	0.113	19.47	60	63.76	—	185	28,860	0.200	2.0	20.1	3,300
	1-11-8		0.222	19.47	100	106.44	—	541	—	0.083	5.3	16.3	2,700
	1-13-8		0.448	19.47	100	106.44	—	639	14,320	0.017	5.0	20.2	3,750
IM6/3100	1-14-9	50/40/10	0.110	19.47	45	47.86	44.70	250	11,330	0.118	1.8	28.1	1,750
	1-20-8		0.224	19.47	100	106.44	96.96	205	20,990	0.103	5.3	23.0	1,000
	1-15-7		0.453	19.47	100	106.44	96.16	991	14,090	0.020	4.9	28.6	2,500
IM6/F650	2-12-9	10/80/10	0.107	19.47	55	58.57	52.51	353	12,290	0.096	5.3	9.9	1,600
	2-11-9		0.216	19.47	100	106.44	96.16	607	20,500	0.072	5.6	12.0	1,900
	2-13-7		0.436	19.47	100	106.44	—	923	15,070	0.028	5.2	13.9	2,700
IM6/F650	2-14-8	50/40/10	0.112	19.47	45	47.86	44.70	308	9,250	0.090	5.2	18.8	4,850
	2-20-7		0.218	19.47	100	106.44	96.16	402	11,920	0.049	5.5	16.9	700
	2-15-8		0.439	19.47	100	106.44	96.16	590	13,610	0.030	5.2	19.8	1,450
ETW													
IM6/3100	1-12-12	10/80/10	0.114	19.47	60	63.76	57.24	199	36,730	0.130	—	14.4	2,700
	1-11-12		0.223	19.47	100	106.44	94.59	559	36,540	0.091	—	14.7	2,500
	1-13-12		0.452	19.47	100	106.44	—	752	17,070	0.017	—	14.9	3,300
IM6/3100	1-14-11	50/40/10	0.109	19.47	45	61.98	43.97	701	10,730	0.120	—	21.8	2,450
	1-20-11		0.225	19.47	100	106.44	95.37	617	19,830	0.090	—	18.1	1,750
	1-15-11		0.452	19.47	100	106.44	96.96	1,928	14,300	0.020	—	21.7	2,000
IM6/F650	2-12-11	10/80/10	0.106	19.47	45	47.86	—	242	17,300	0.110	—	9.2	1,930
	2-11-11		0.217	19.47	100	106.44	93.81	222	20,090	0.045	—	9.4	1,200
	2-13-11		0.431	19.47	100	106.44	—	420	12,240	0.027	—	11.8	2,300
IM6/F650	2-14-11	50/40/10	0.110	19.47	45	61.98	43.73	430	17,180	0.086	—	17.3	1,800
	2-20-12		0.216	19.47	100	106.44	—	701	17,290	0.052	—	14.2	600
	2-15-10		0.440	19.47	100	106.44	96.16	181	12,410	0.027	—	15.6	1,150

GP83-0089-1-T

Figure B-134. Visible Impact Damage Data Table

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

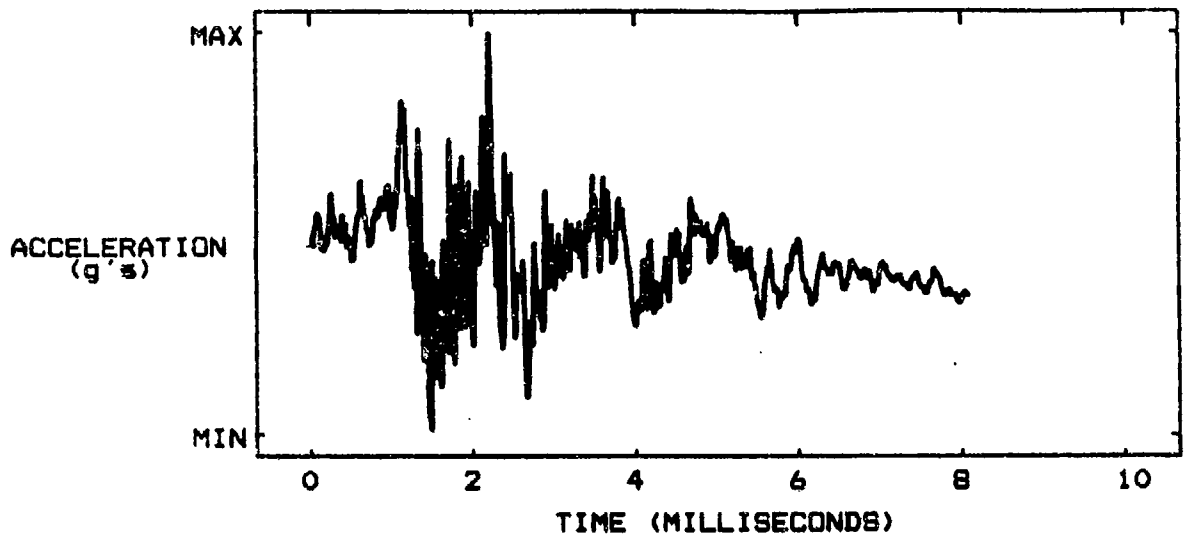
SPECIMEN I.D. 1-12-8

THICKNESS .113 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 39.3 IN

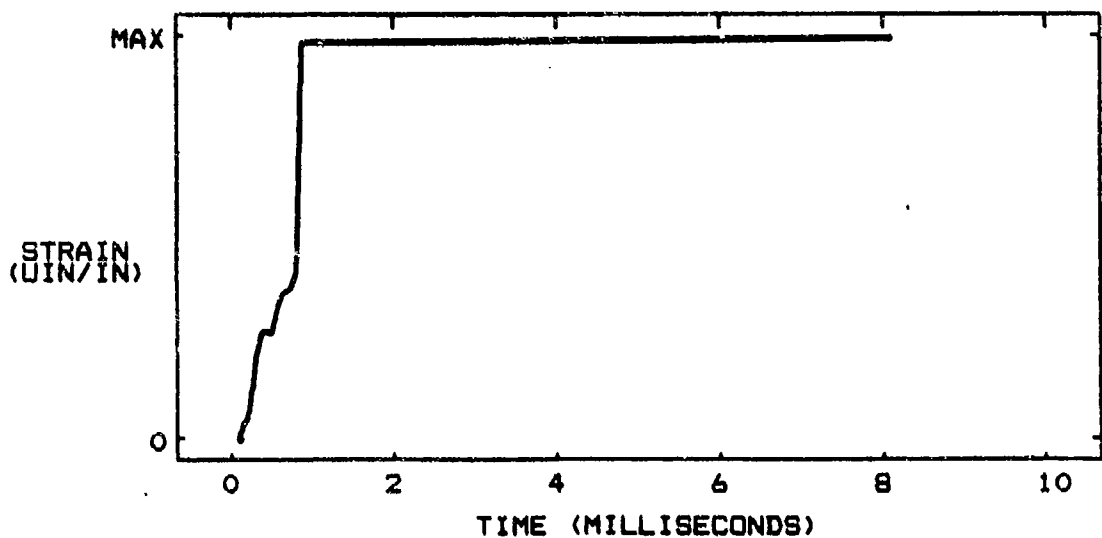
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -170 g's      MAXIMUM ACCELERATION 185.0 g's

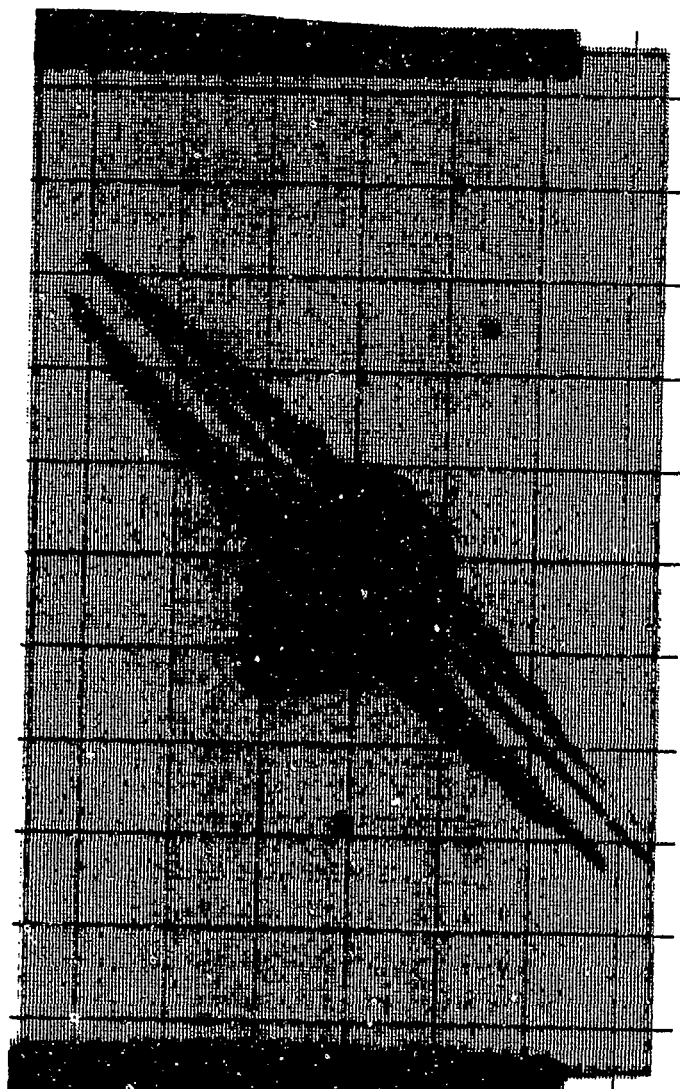
INTEGRATED TOTAL VELOCITY -67.0 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 28861 UIN/IN

Figure B-135. Panel 1-12-8 Impact Response Data



Specimen 1-12-8

Figure B-136. Panel 1-12-8 C-Scan

# CSAI - IM6/3100

PANEL 1-12-8 (RTD)

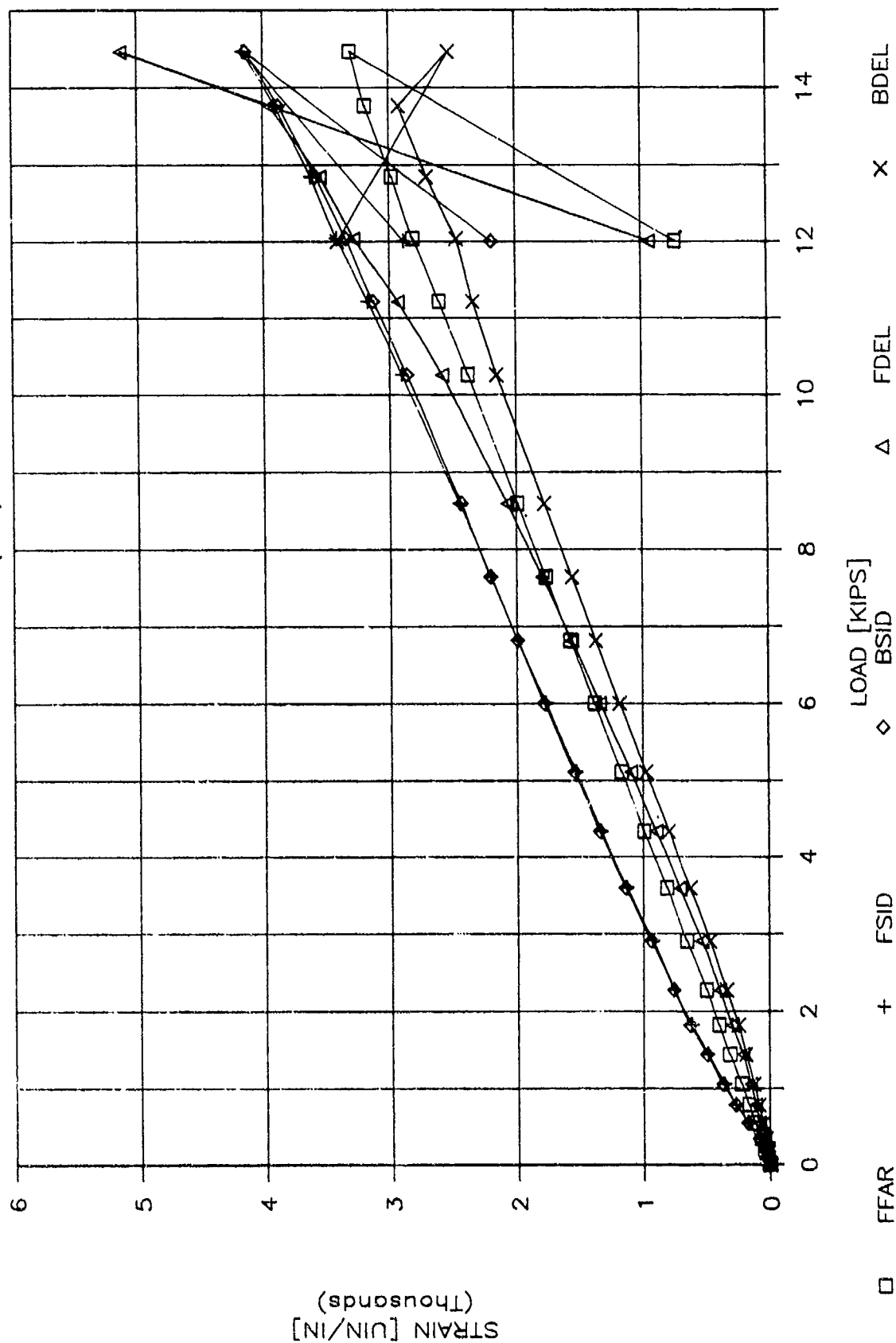


Figure B-137. Panel 1-12-8 Residual Compression Data

# LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

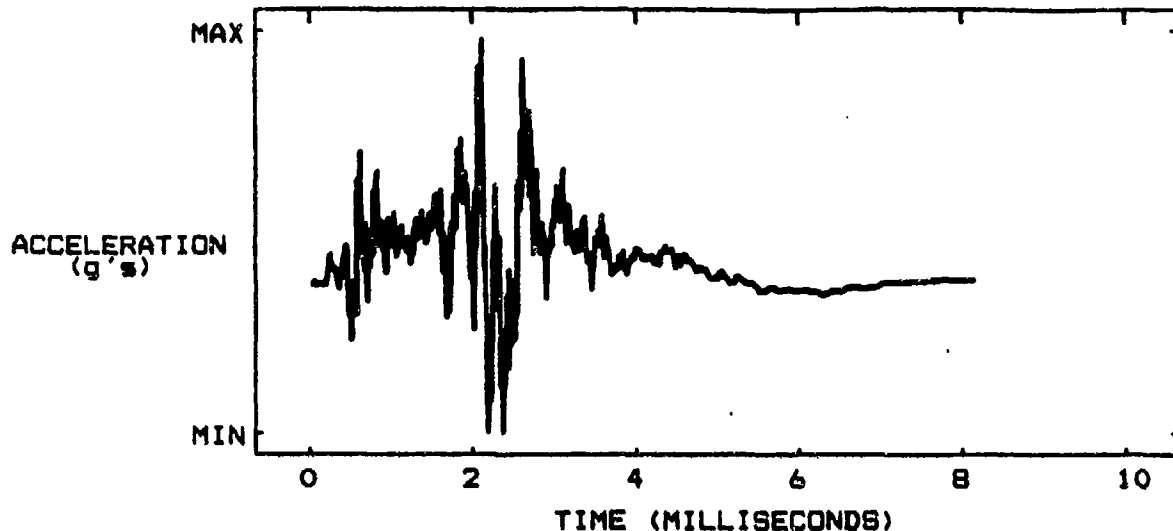
SPECIMEN I.D. 1-11-8

THICKNESS .222 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

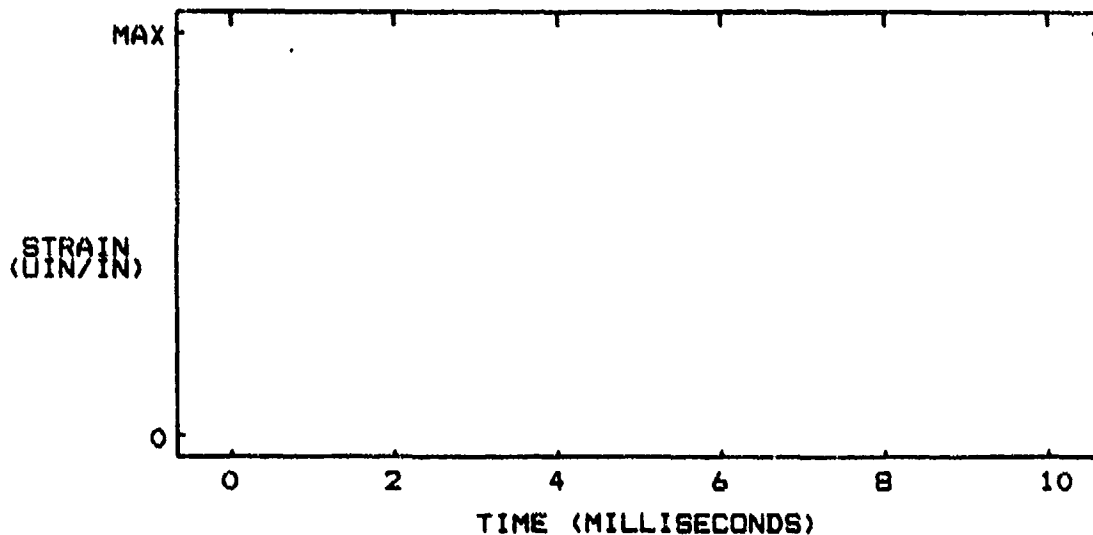
## ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -320 g's      MAXIMUM ACCELERATION 541 g's

INTEGRATED TOTAL VELOCITY 139.56 IN/SEC

## PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN no data IN/IN

Figure B-138. Panel 1-11-8 Impact Response Data



**Specimen 1-11-8**

**Figure B-139. Panel 1-11-8 C-Scan**

# CSAI - IM6/3100

PANEL 1-11-8 (RTD)

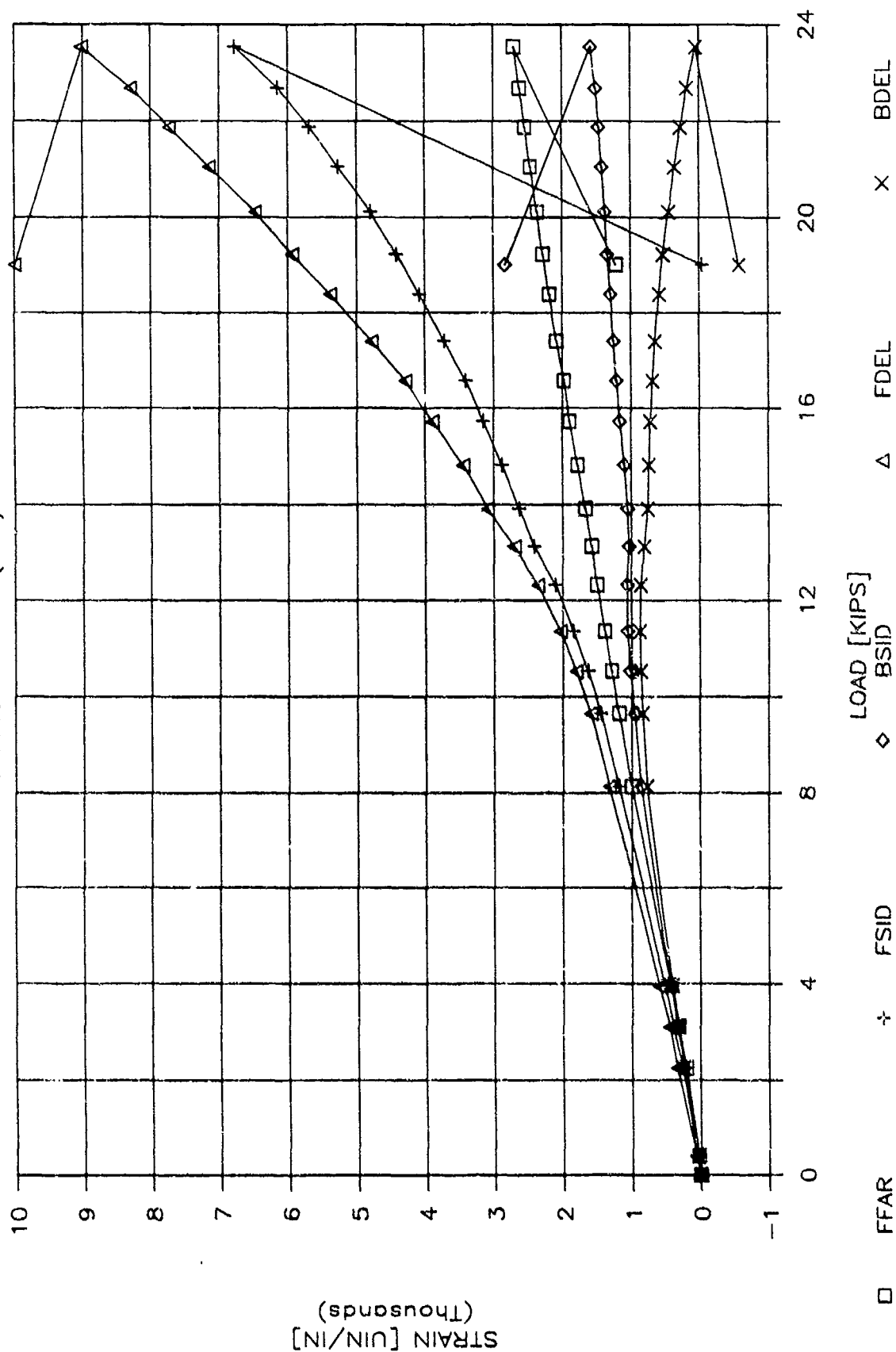


Figure B-140. Panel 1-11-8 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

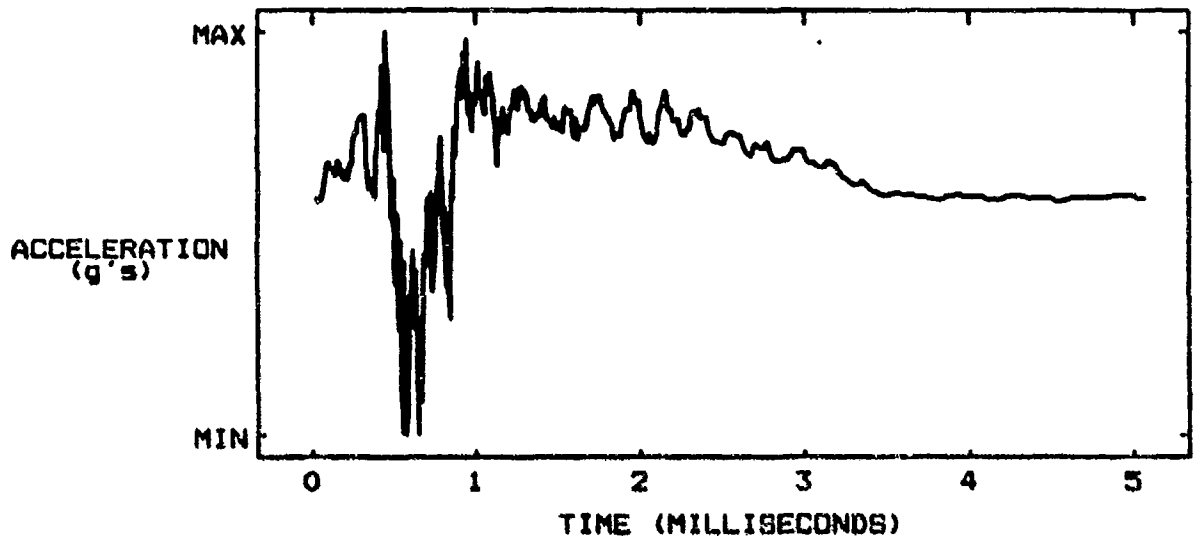
SPECIMEN I.D. 1-13-8

THICKNESS .448 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

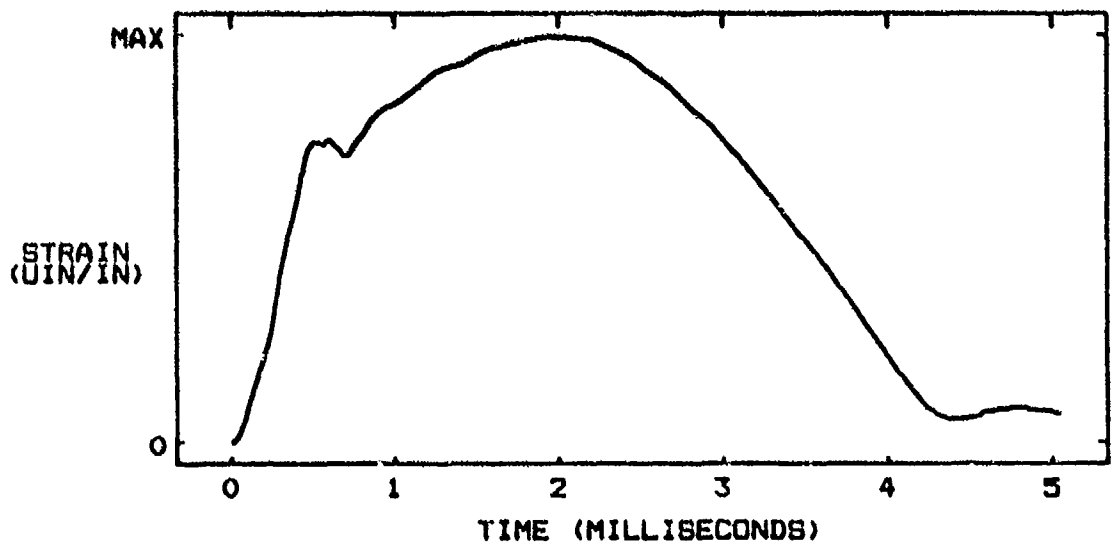
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -893 g's      MAXIMUM ACCELERATION 639.00 g's

INTEGRATED TOTAL VELOCITY 241.962 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14318 UIN/IN

Figure B-141. Panel 1-13-8 Impact Response Data



**Specimen 1-13-8**

**Figure B-142. Panel 1-13-8 C-Scan**

# CSAI - IM6/3100

PANEL 1-13-8 (RTD)

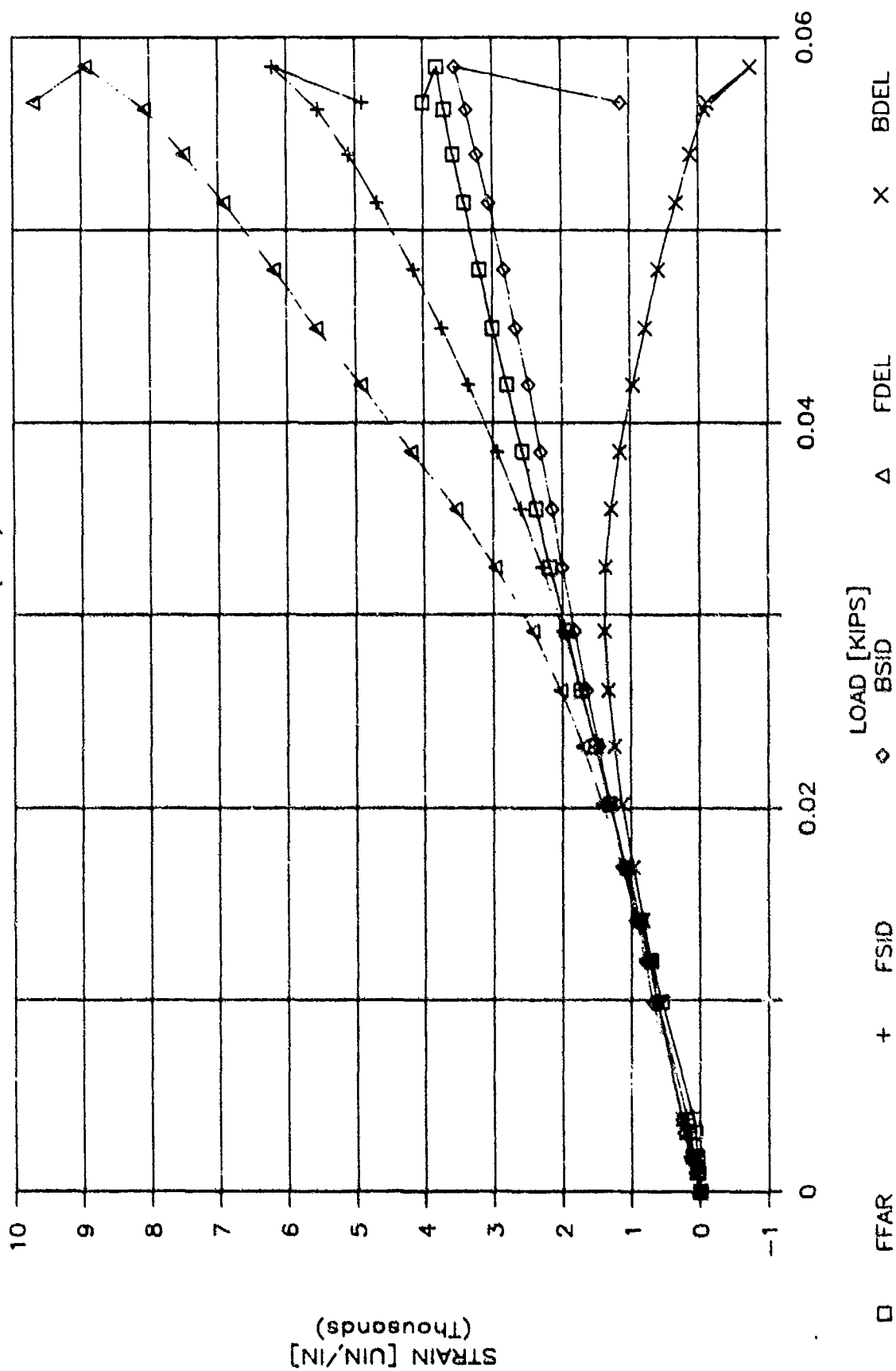


Figure B-143. Panel 1-13-8 Residual Compression Data

# LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

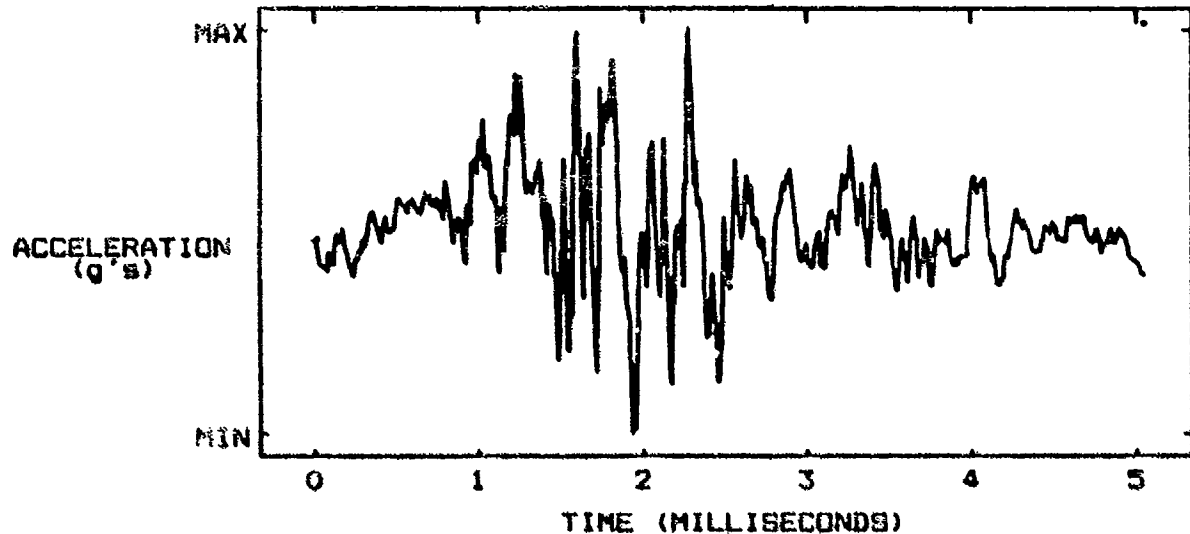
SPECIMEN I.D. 1-14-9

THICKNESS .110 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 29.5 IN

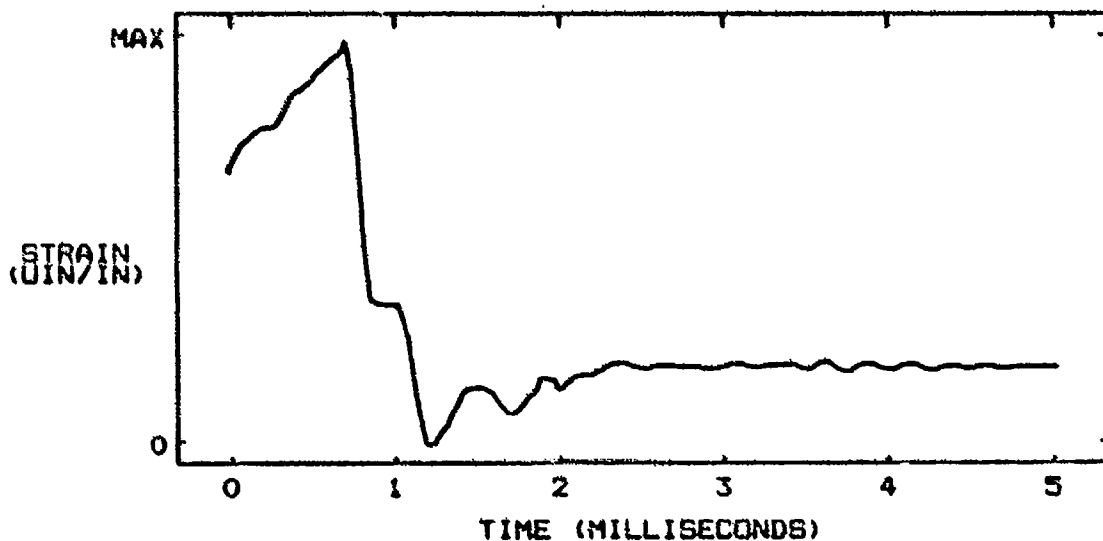
## ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -227.3 g's      MAXIMUM ACCELERATION 250 g's

INTEGRATED TOTAL VELOCITY 25.302 IN/SEC

## PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 11329 IN/IN

Figure B-144. Panel 1-14-9 Impact Response Data



Specimen 1-14-9

Figure B-145. Panel 1-14-9 C-Scan

# CSAI - IM6/3100

PANEL 1-14-9 (RTD)

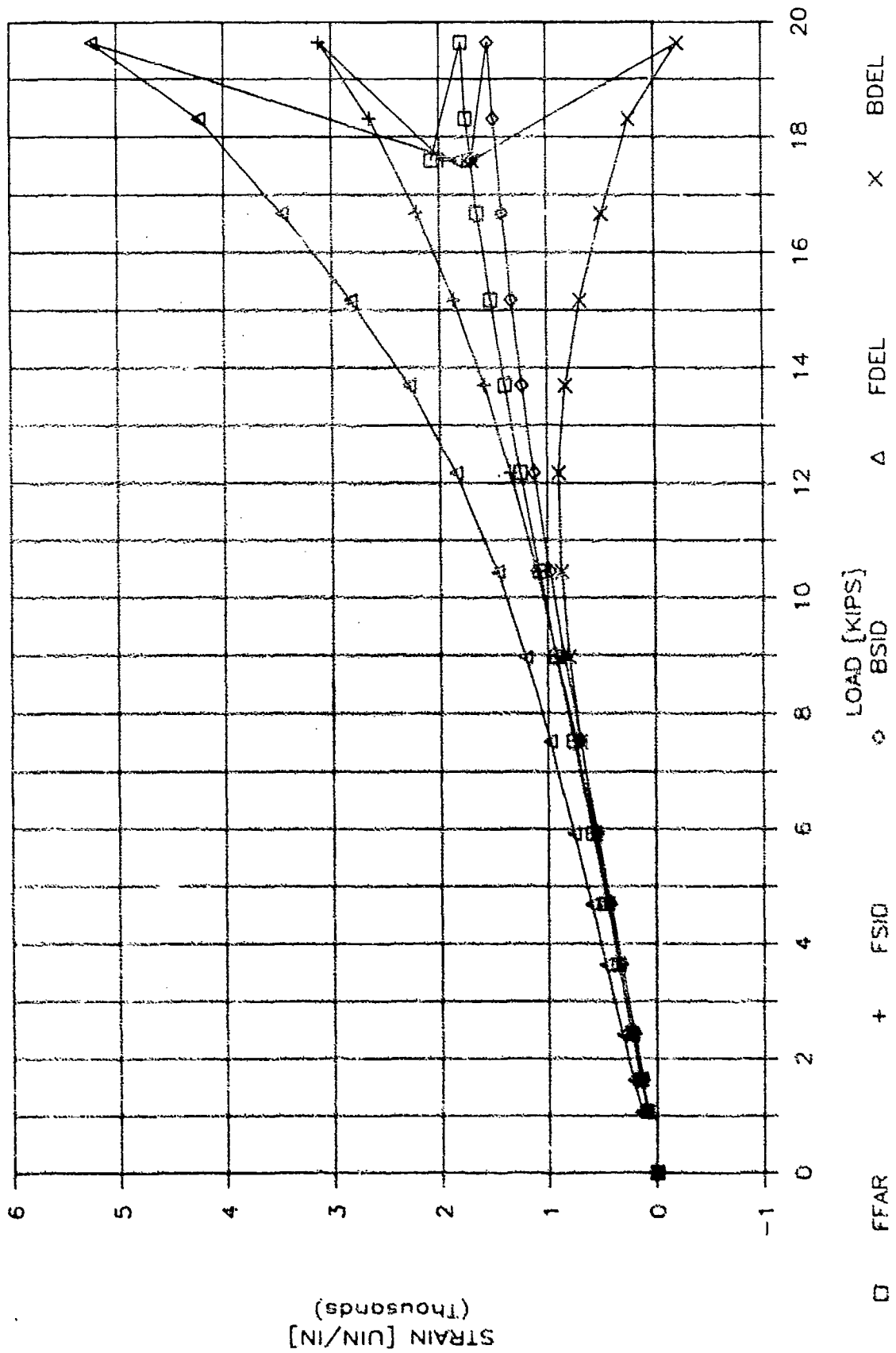


Figure B-146. Panel 1-14-9 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

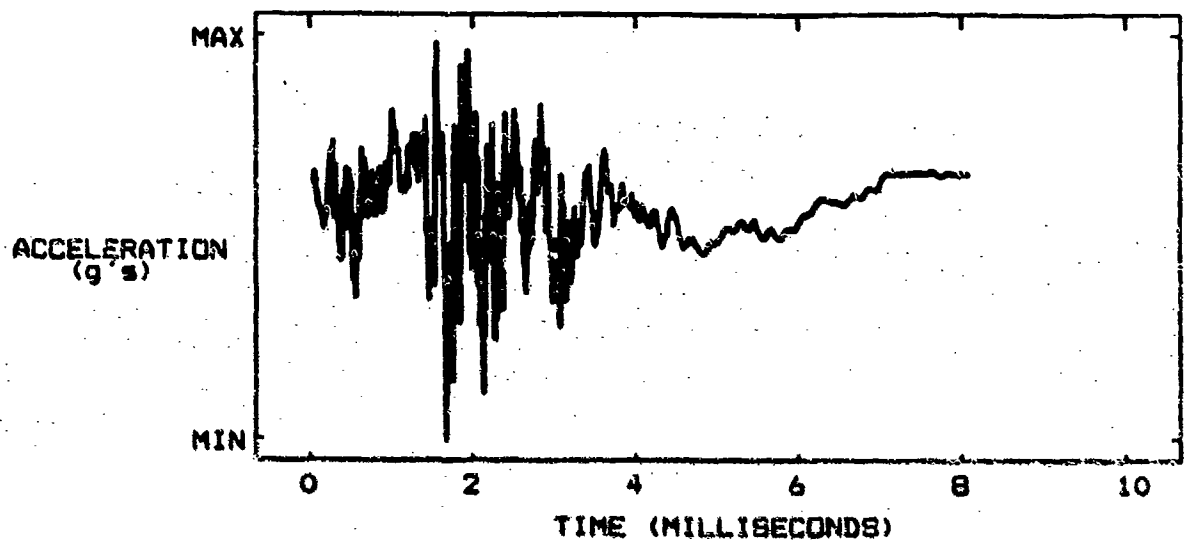
SPECIMEN I.D. 1-20-8

THICKNESS .224 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

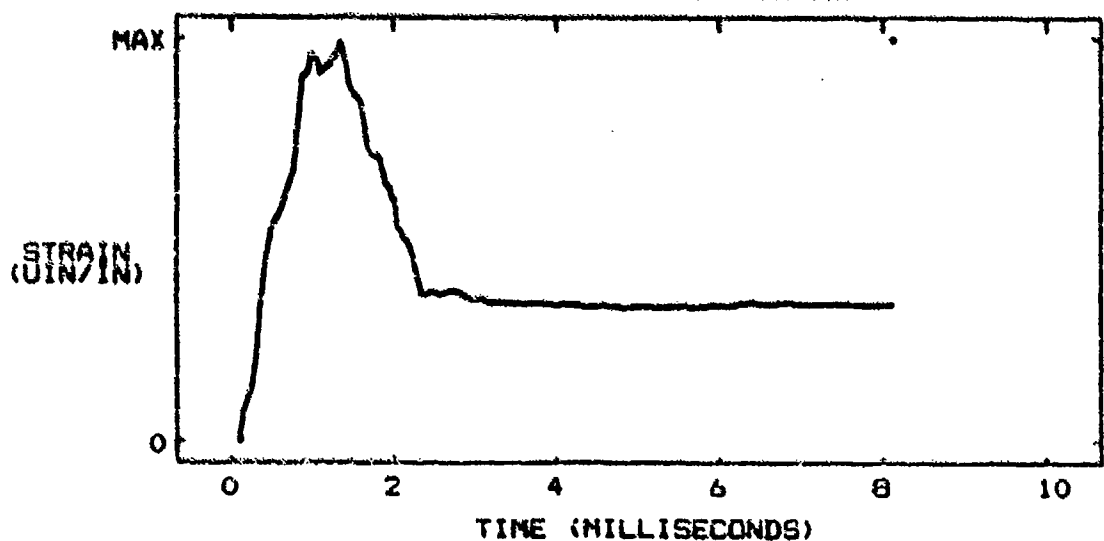
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -410 g's      MAXIMUM ACCELERATION 205.00 g's

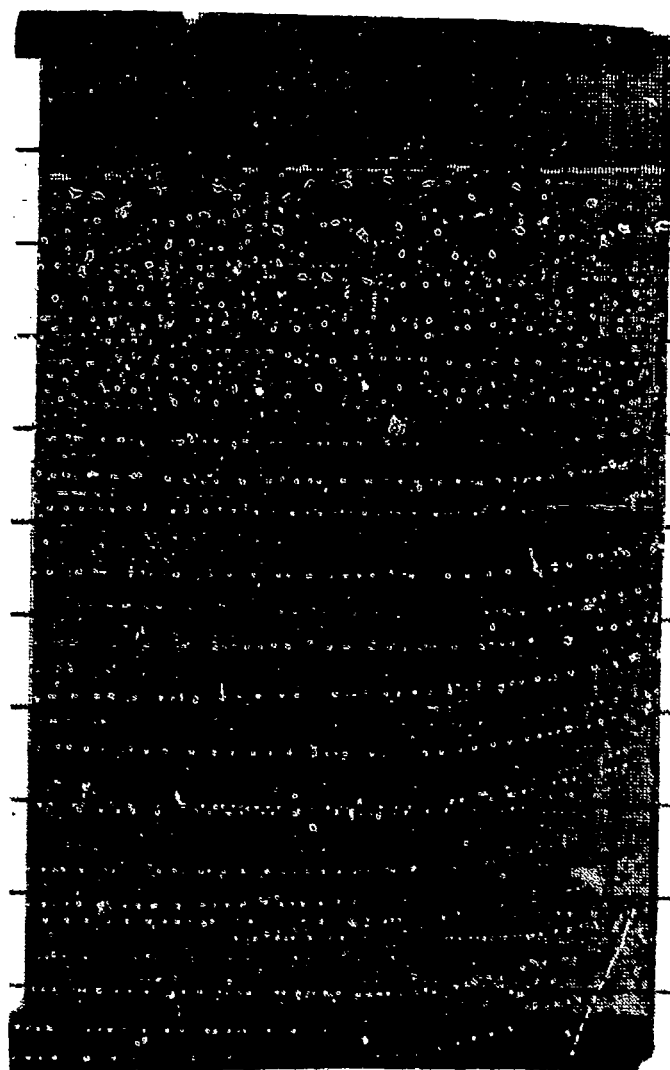
INTEGRATED TOTAL VELOCITY -122.6 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 20990 UIN/IN

Figure B-147. Panel 1-20-8 Impact Response Data



**Specimen 1-20-8**

**Figure B-148. Panel 1-20-8 C-Scan**

# CSAI - IM6/3100

PANEL 1-20-8 (RTD)

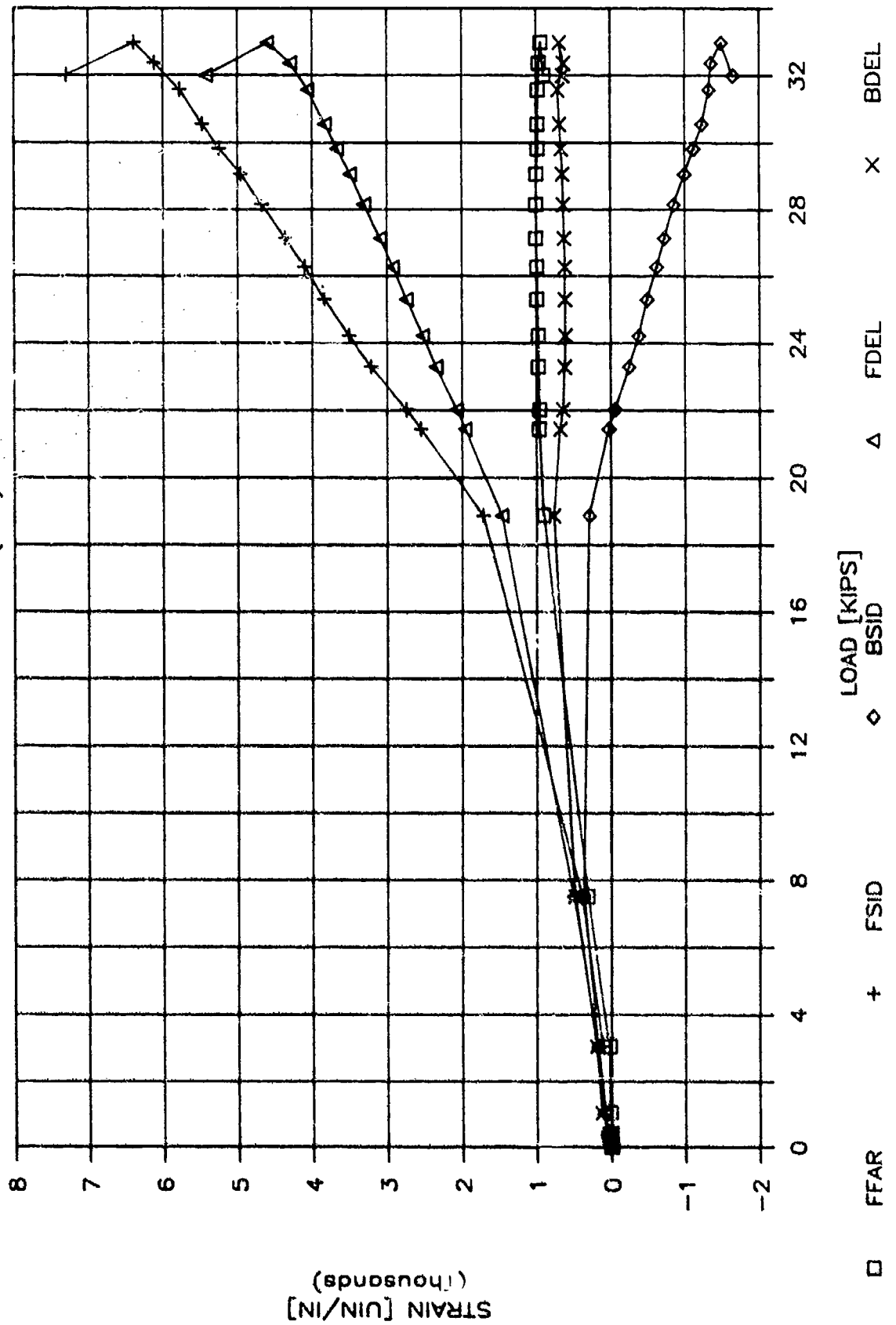


Figure B-149. Panel 1-20-8 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

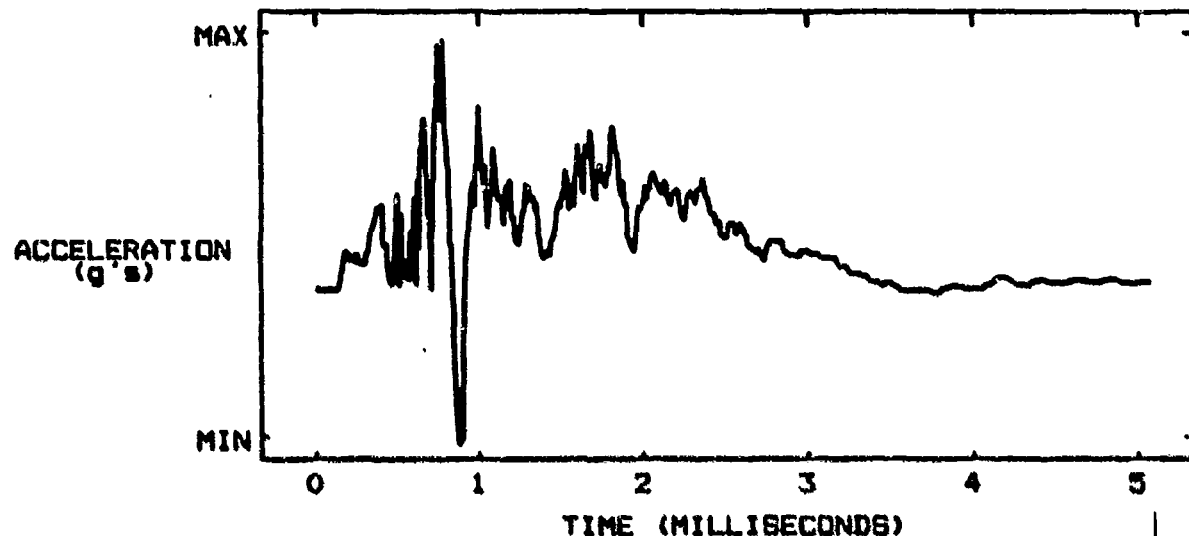
SPECIMEN I.D. 1-15-7

THICKNESS .453 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

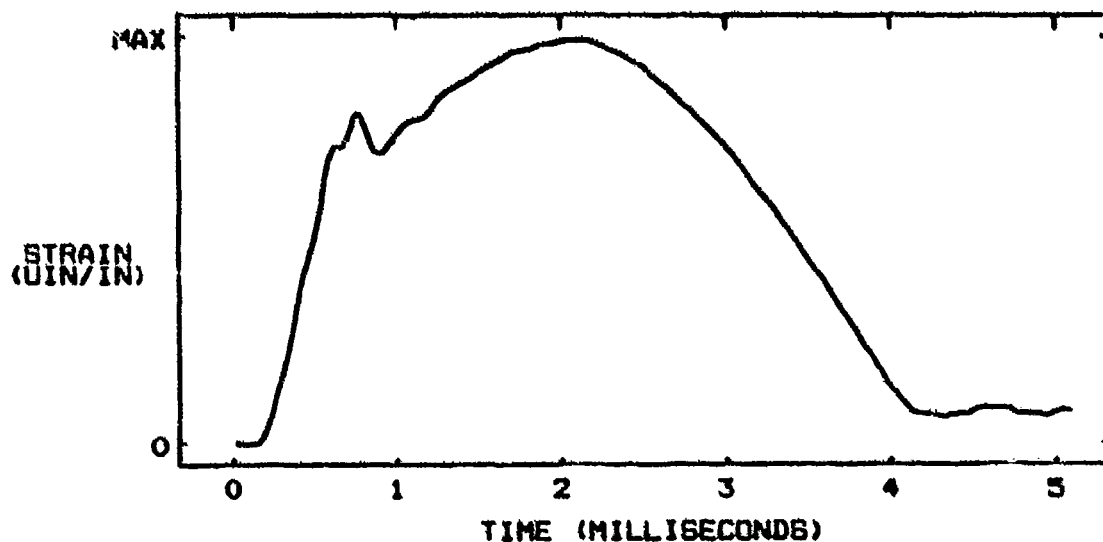
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -610 g's      MAXIMUM ACCELERATION 991 g's

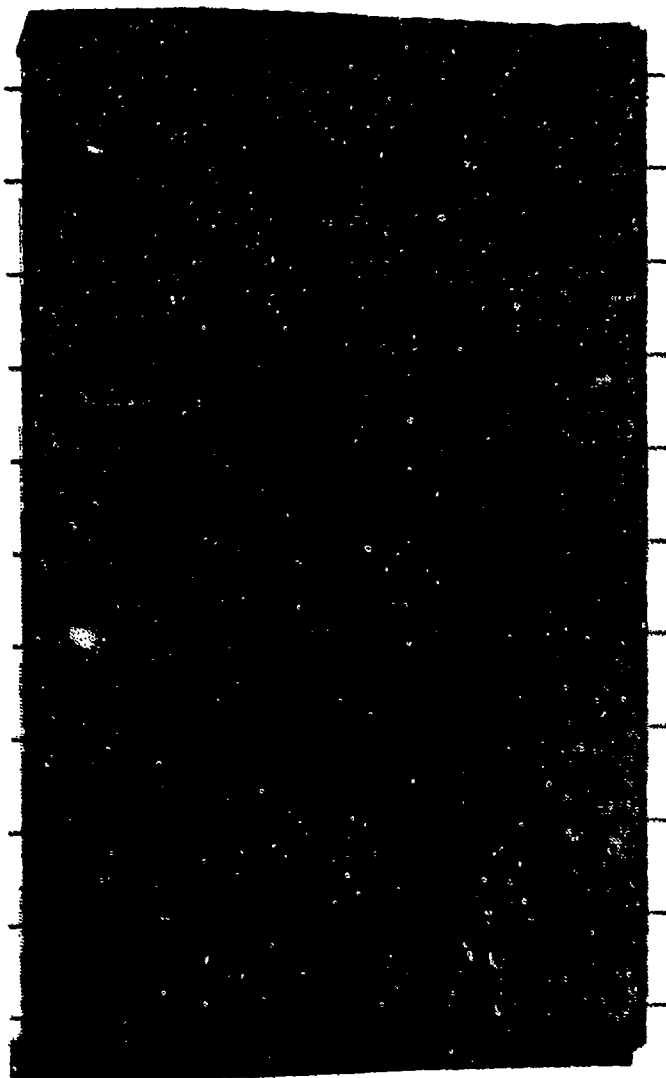
INTEGRATED TOTAL VELOCITY 350.34 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14094 UIN/IN

Figure B-150. Panel 1-15-7 Impact Response Data



**Specimen 1-15-7**

**Figure B-151. Panel 1-15-7 C-Scan**

# CSAI - IM6/3100

PANEL 1-15-7 (RTD)

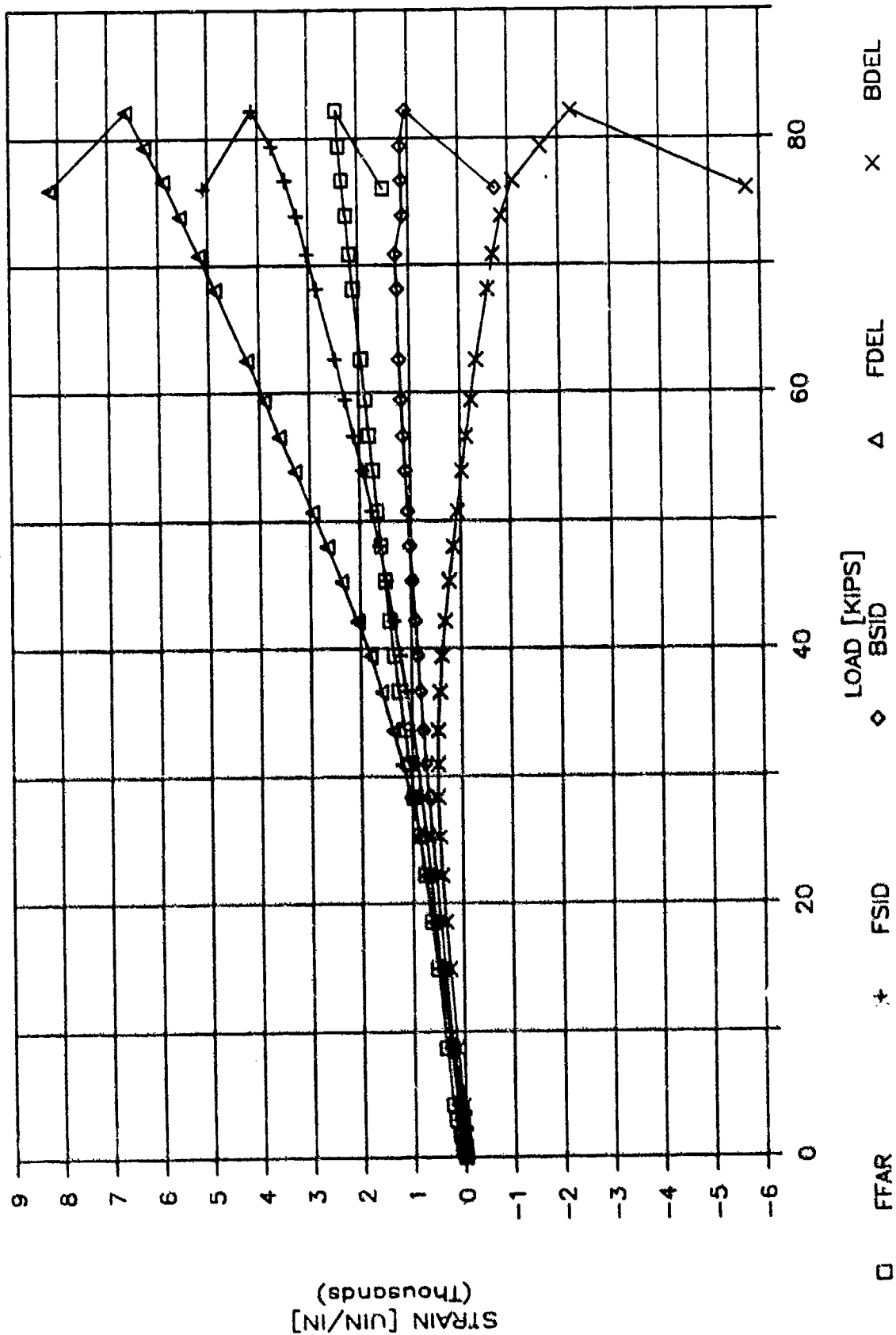


Figure B-152. Panel 1-15-7 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

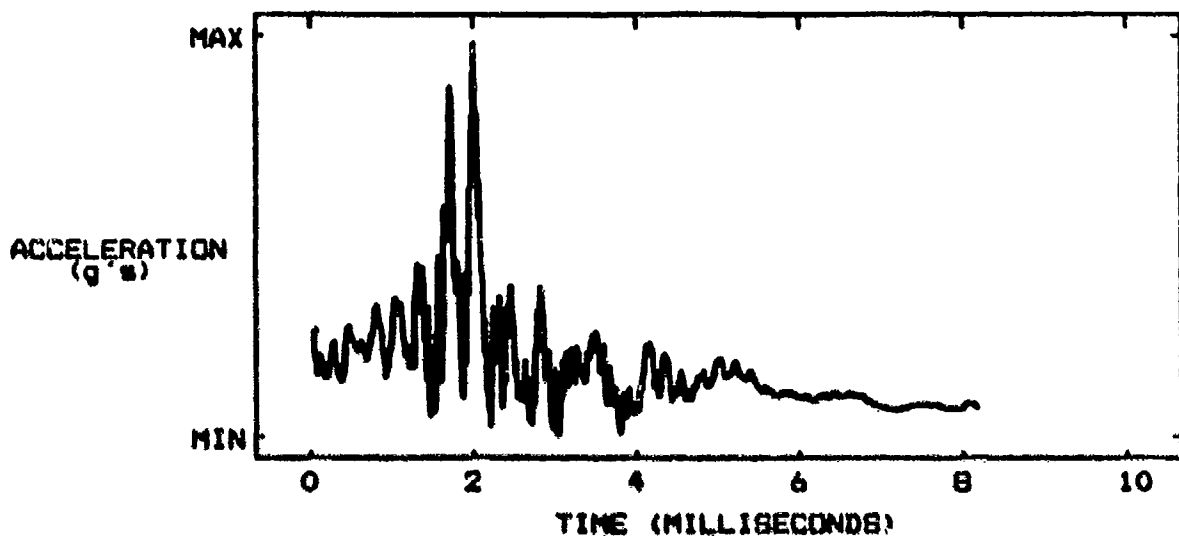
SPECIMEN I.D. 2-12-9

THICKNESS .107 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 36.1 IN

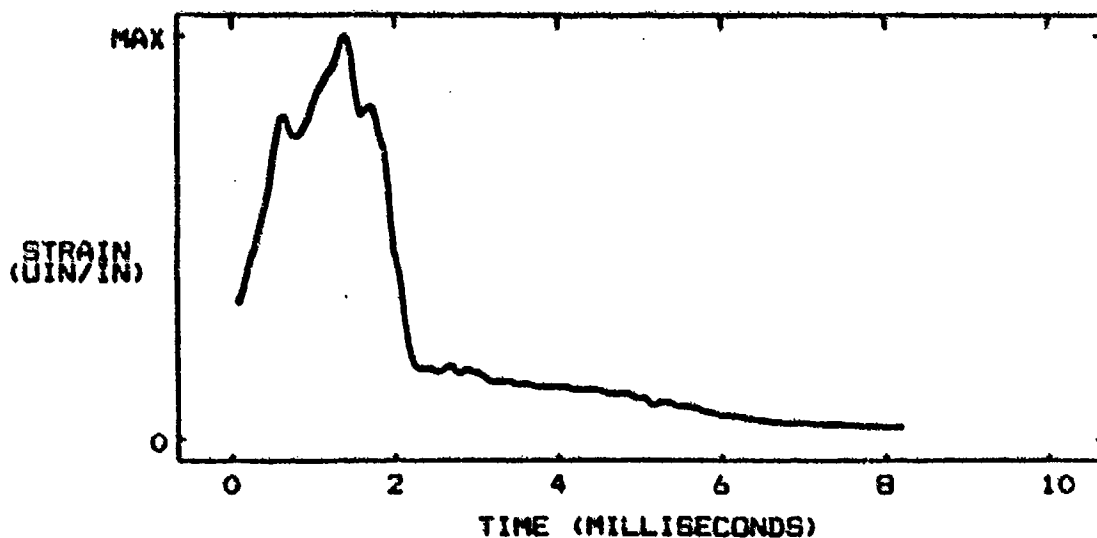
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -125 g's      MAXIMUM ACCELERATION 353.20 g's

INTEGRATED TOTAL VELOCITY -184.82 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 12294 UIN/IN

Figure B-153. Panel 2-12-9 Impact Response Data



**Specimen 2-12-9**

**Figure B-154. Panel 2-12-9 C-Scan**

# CSAI - IM6/F650

PANEL 2-12-9 (RTD)

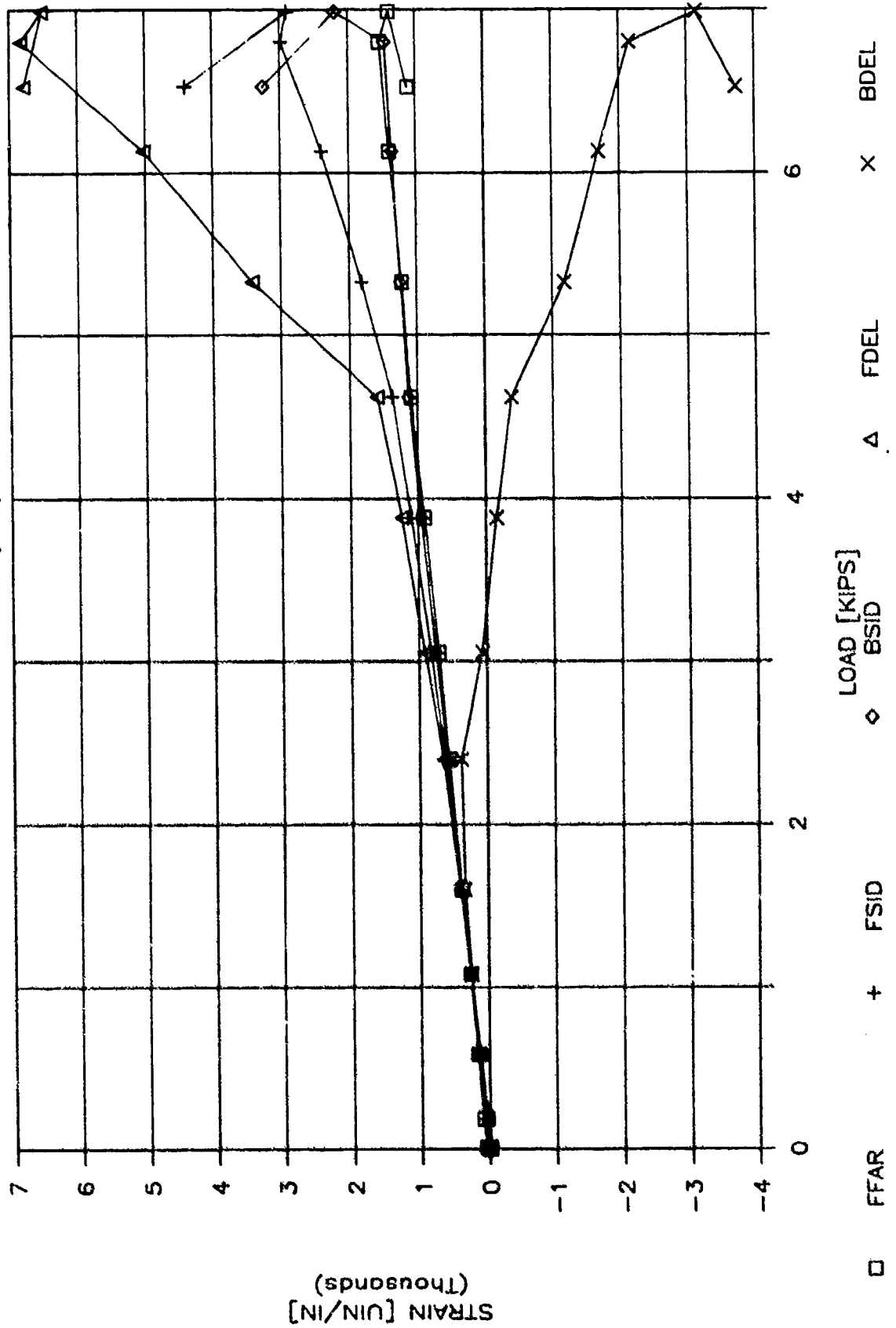


Figure B-155. Panel 2-12-9 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

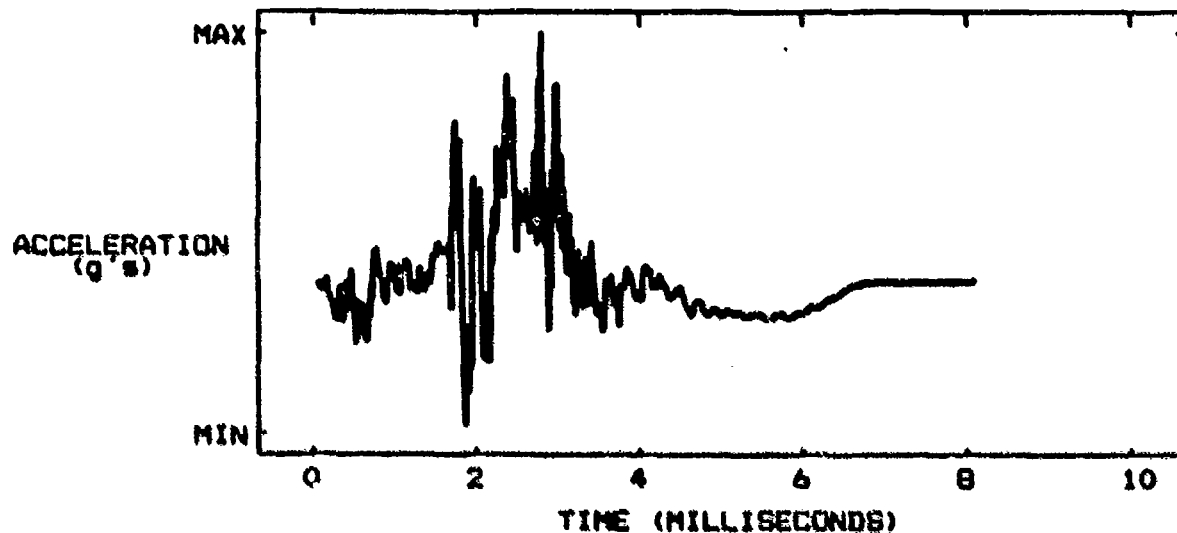
SPECIMEN I.D. 2-11-9

THICKNESS .216 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

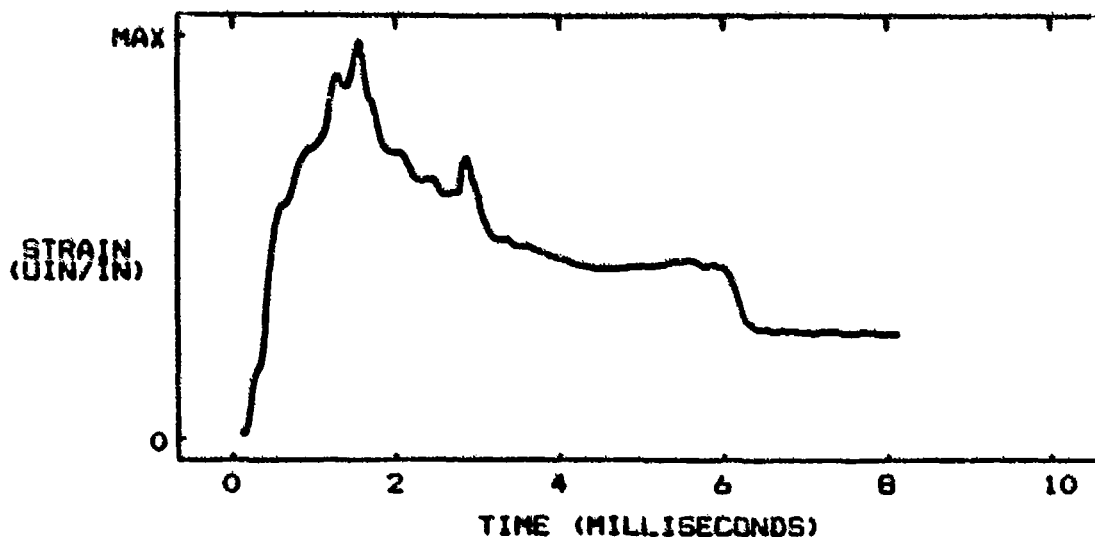
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -363 g's      MAXIMUM ACCELERATION 607.00 g's

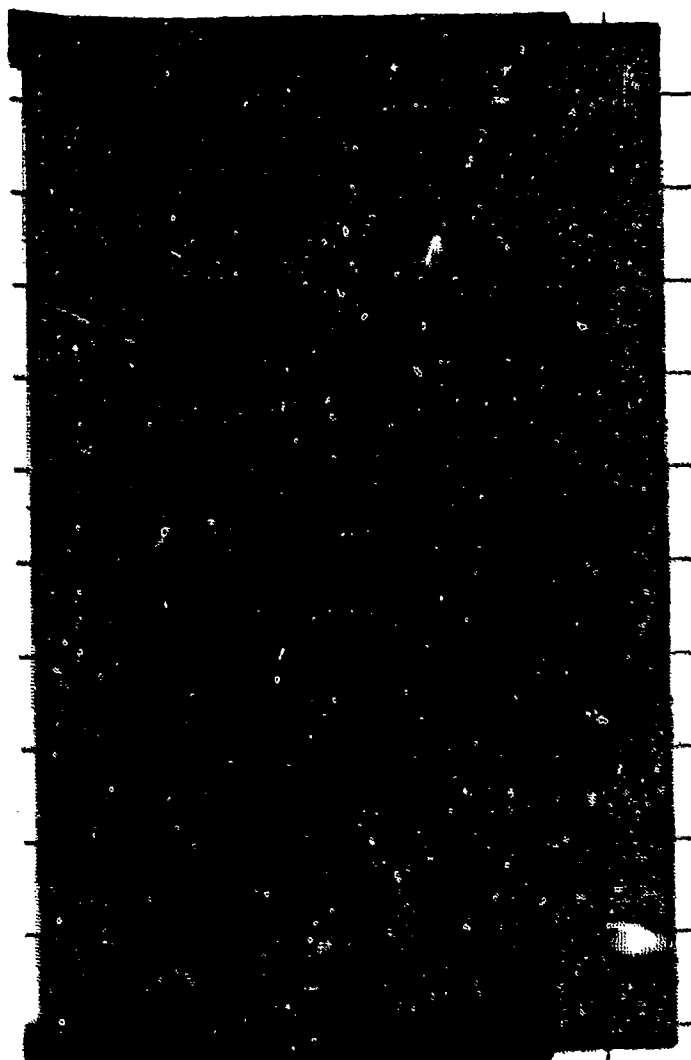
INTEGRATED TOTAL VELOCITY 32.599 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 20503 UIN/IN

Figure B-158. Panel 2-11-9 Impact Response Data



**Specimen 2-11-9**

**Figure B-157. Panel 2-11-9 C-Scan**

# CSA1 - IM6/F650

PANEL 2-11-9 (RTD)

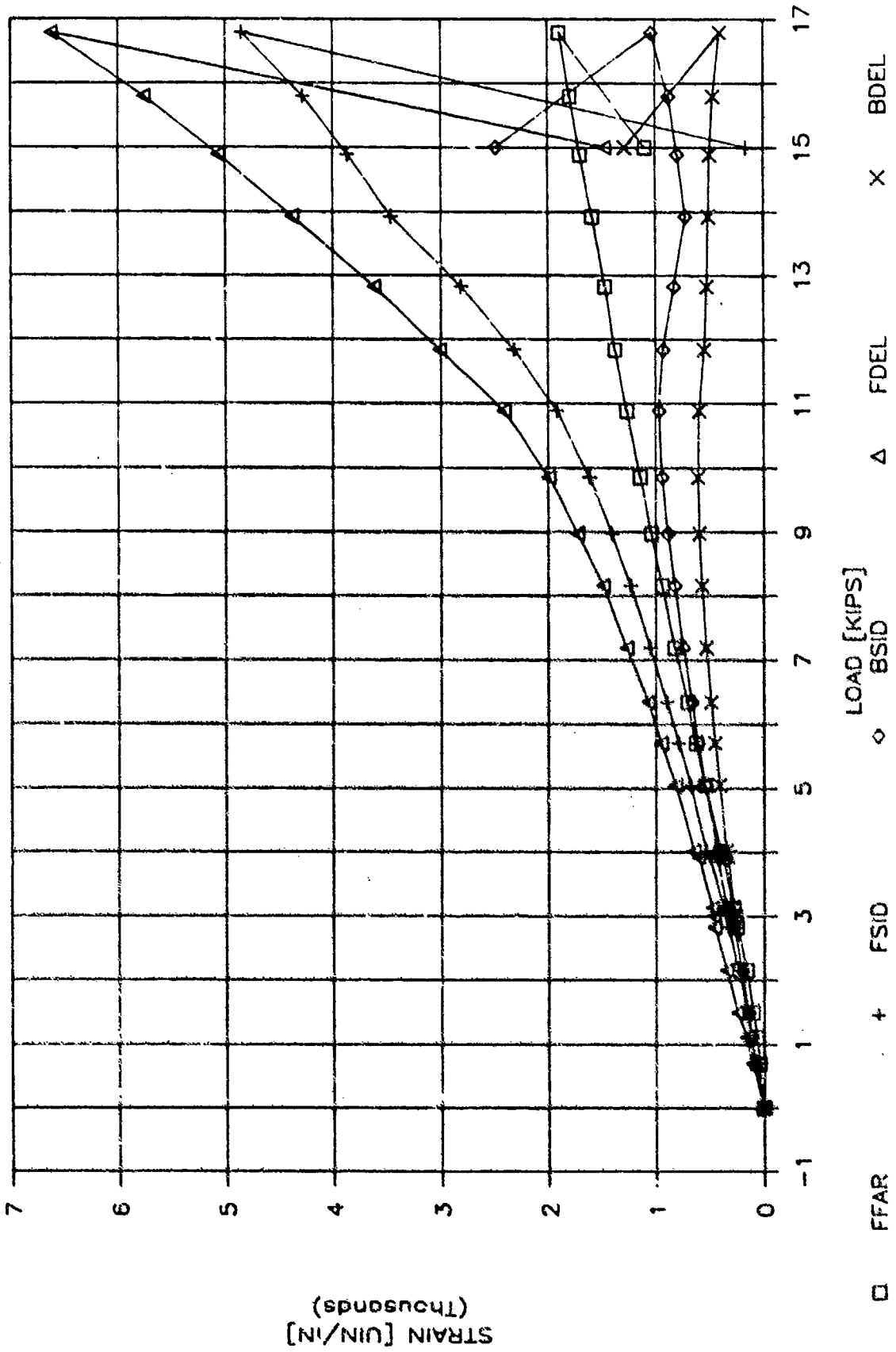


Figure B-158. Panel 2-11-9 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

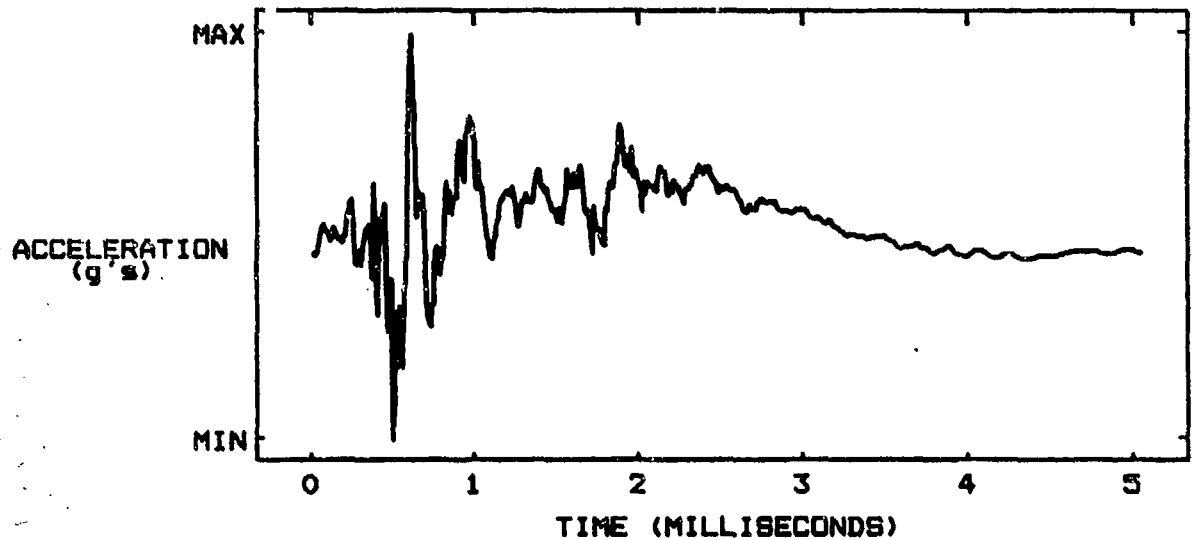
SPECIMEN I.D. 2-13-7

THICKNESS .436 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

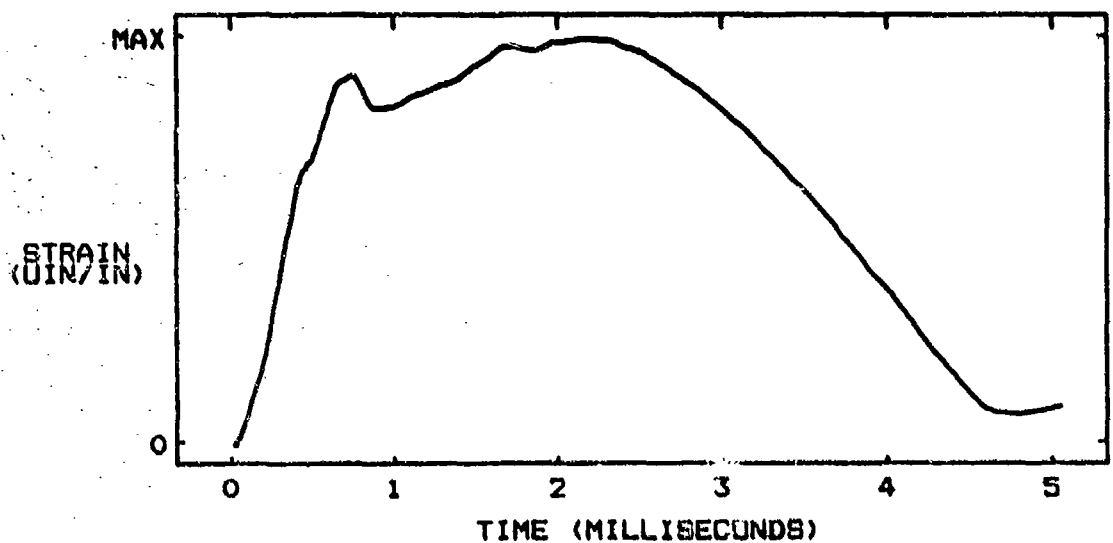
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -470 g's      MAXIMUM ACCELERATION 922.80 g's

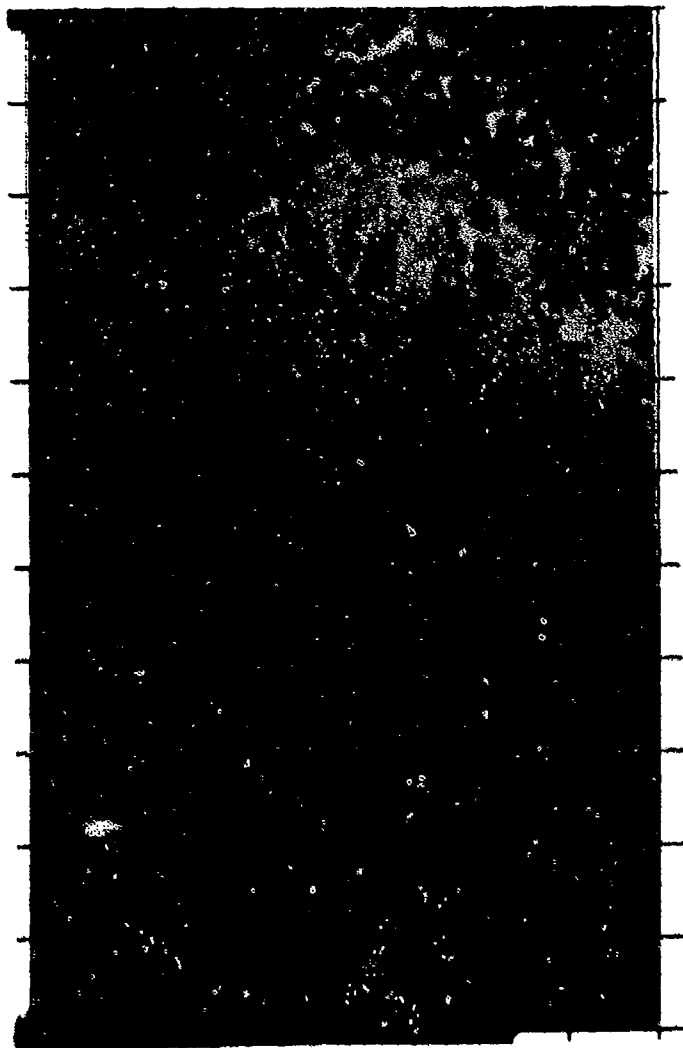
INTEGRATED TOTAL VELOCITY 253.27 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 15068 UIN/IN

Figure B-159. Panel 2-13-7 Impact Response Data



**Specimen 2-13-7**

**Figure B-160. Panel 2-13-7 C-Scan**

# CSAI - IM6/F650

PANEL 2-13-7 (RTD)

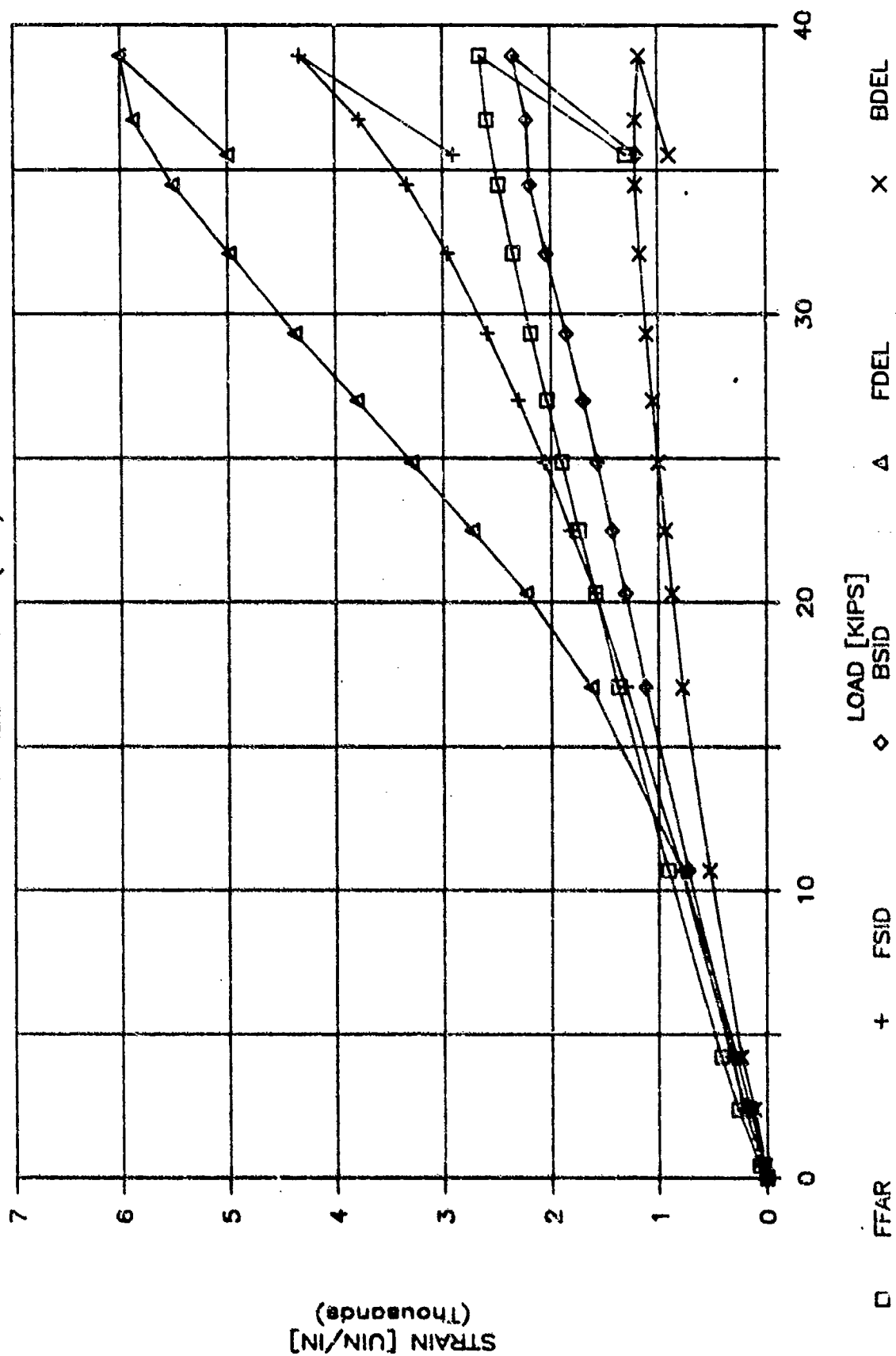


Figure B-161. Panel 2-13-7 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

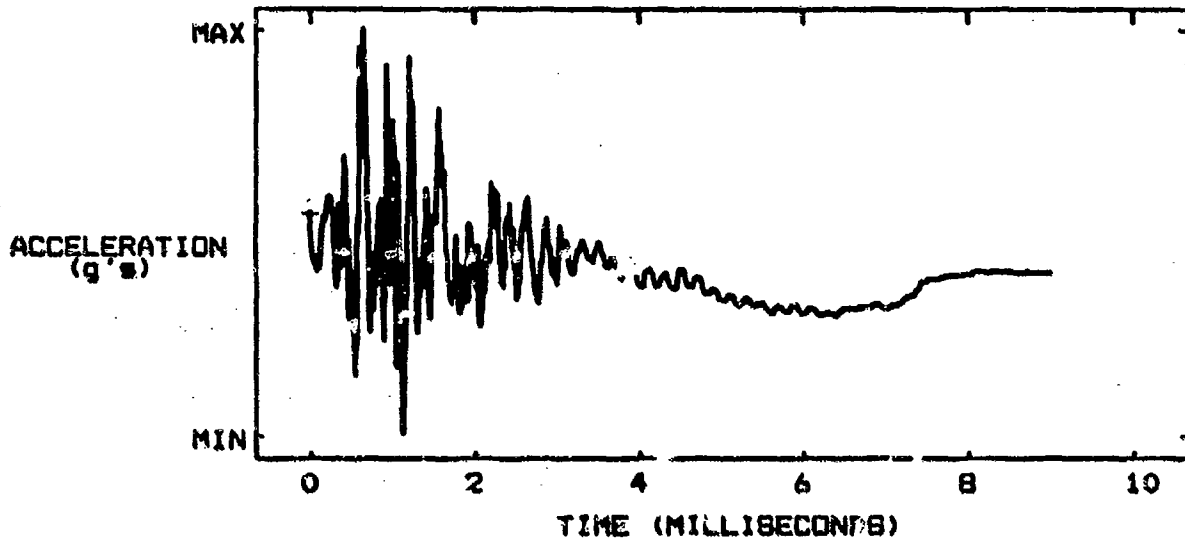
SPECIMEN I.D. 2-14-8

THICKNESS .112 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 29.5 IN

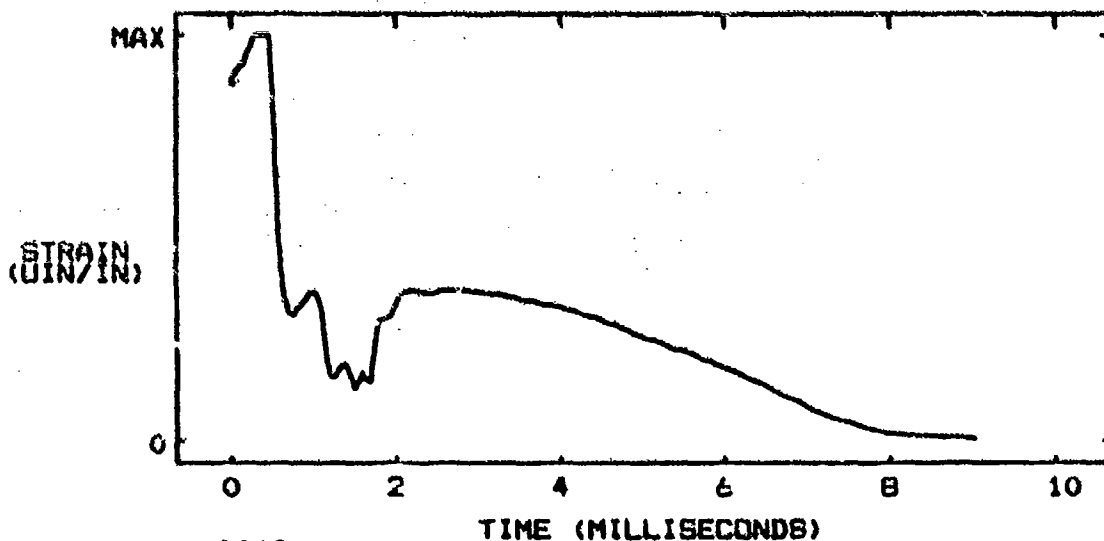
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -372.8 g's      MAXIMUM ACCELERATION 308 g's

INTEGRATED TOTAL VELOCITY -36.271 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 9248 IN/IN

Figure B-162. Panel 2-14-8 Impact Response Data



**Specimen 2-14-8**

**Figure B-163. Panel 2-14-8 C-Scan**

# CSAI - IM6/F650

PANEL 2-14-8 (RTD)

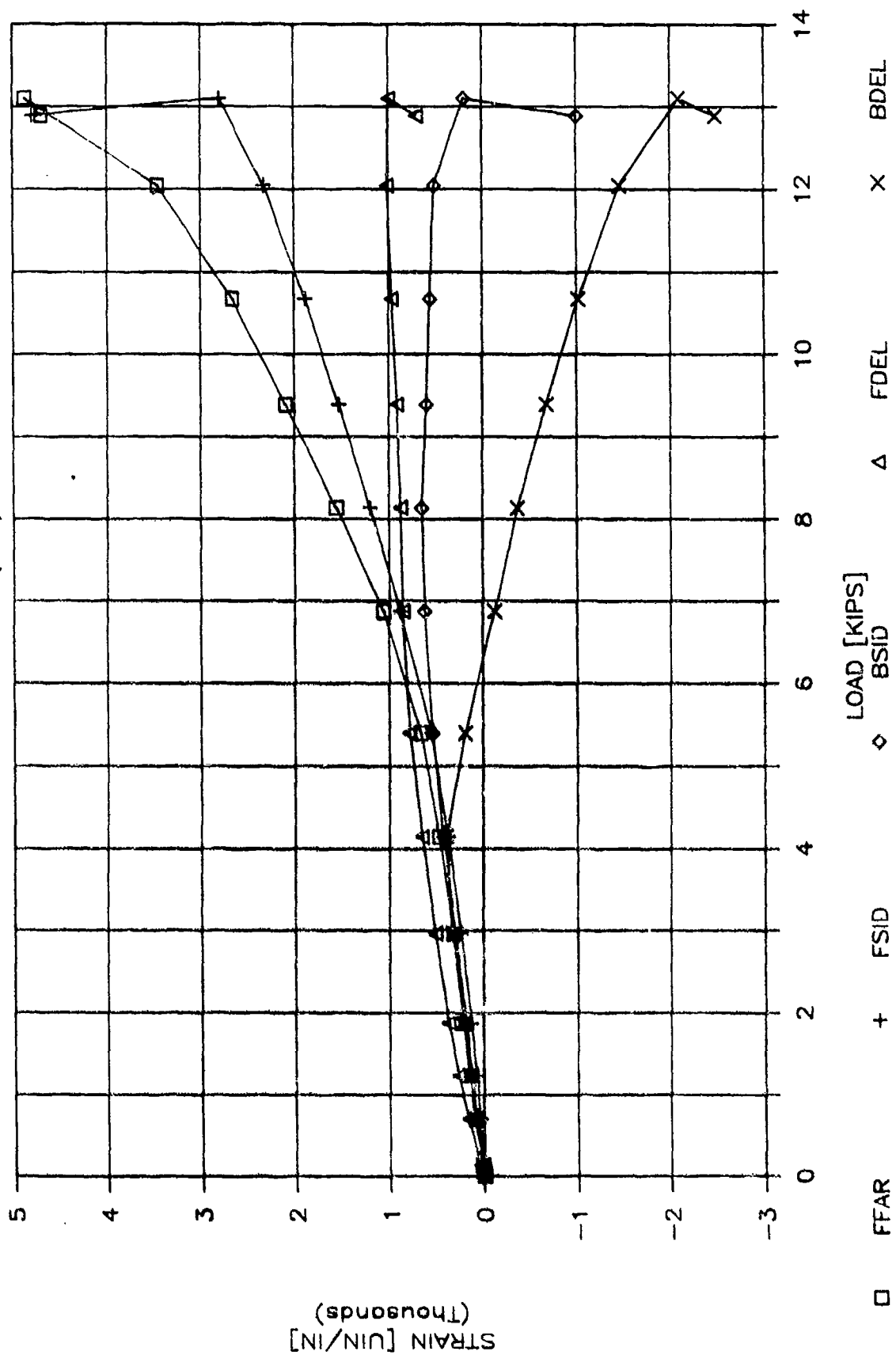


Figure B-164. Panel 2-14-8 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

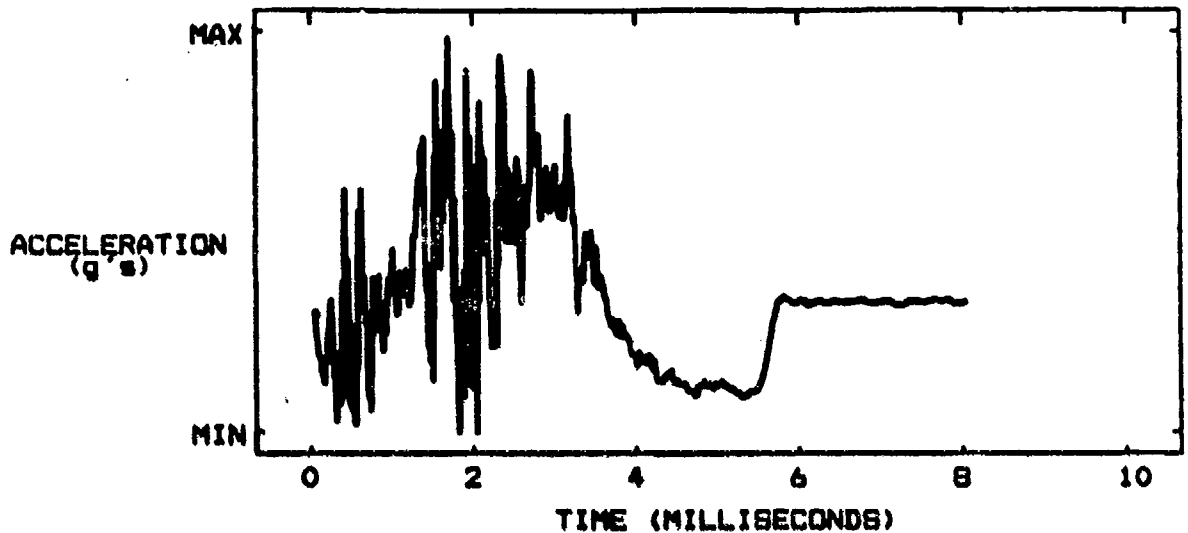
SPECIMEN I.D. 2-20-7

THICKNESS .218 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

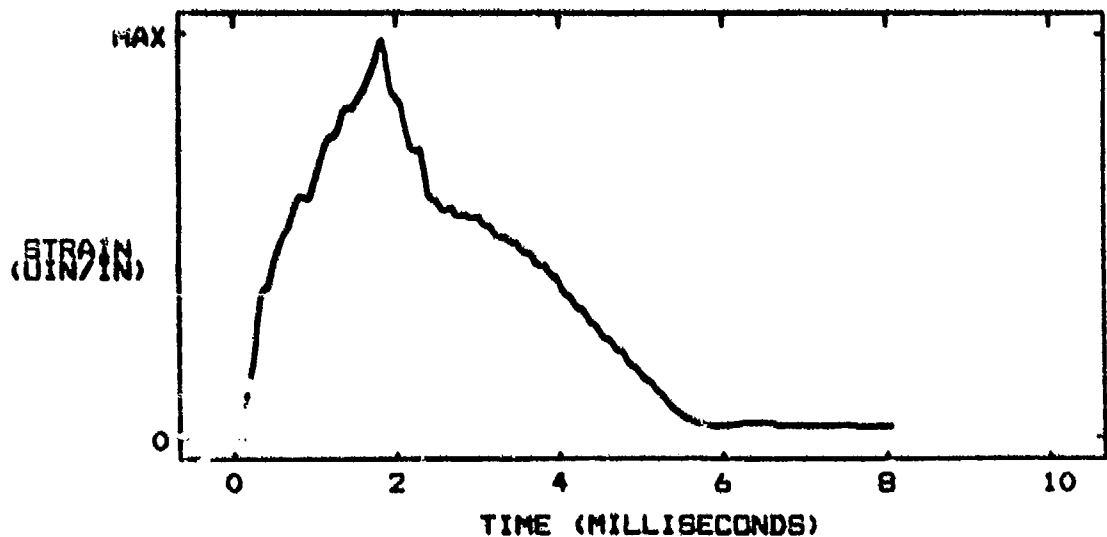
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -161 g's      MAXIMUM ACCELERATION 402.34 g's

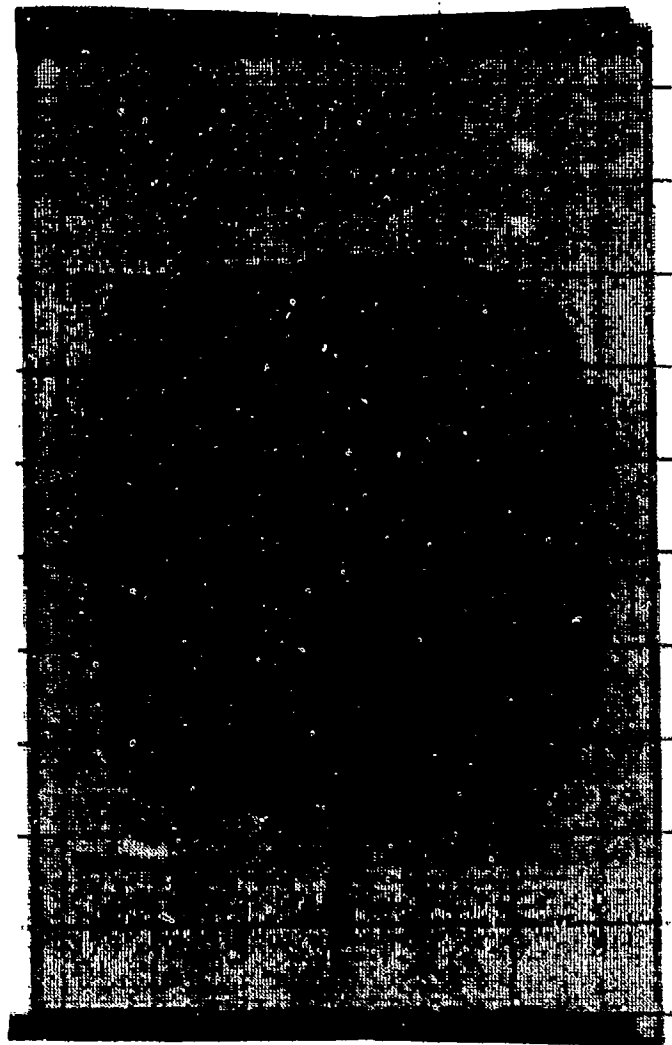
INTEGRATED TOTAL VELOCITY 69.964 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 11919 UIN/IN

Figure B-165. Panel 2-20-7 Impact Response Data



**Specimen 2-20-7**

**Figure B-168. Panel 2-20-7 C-Scan**

# CSA1 - IM6/F650

PANEL 2-20-7 (RTD)

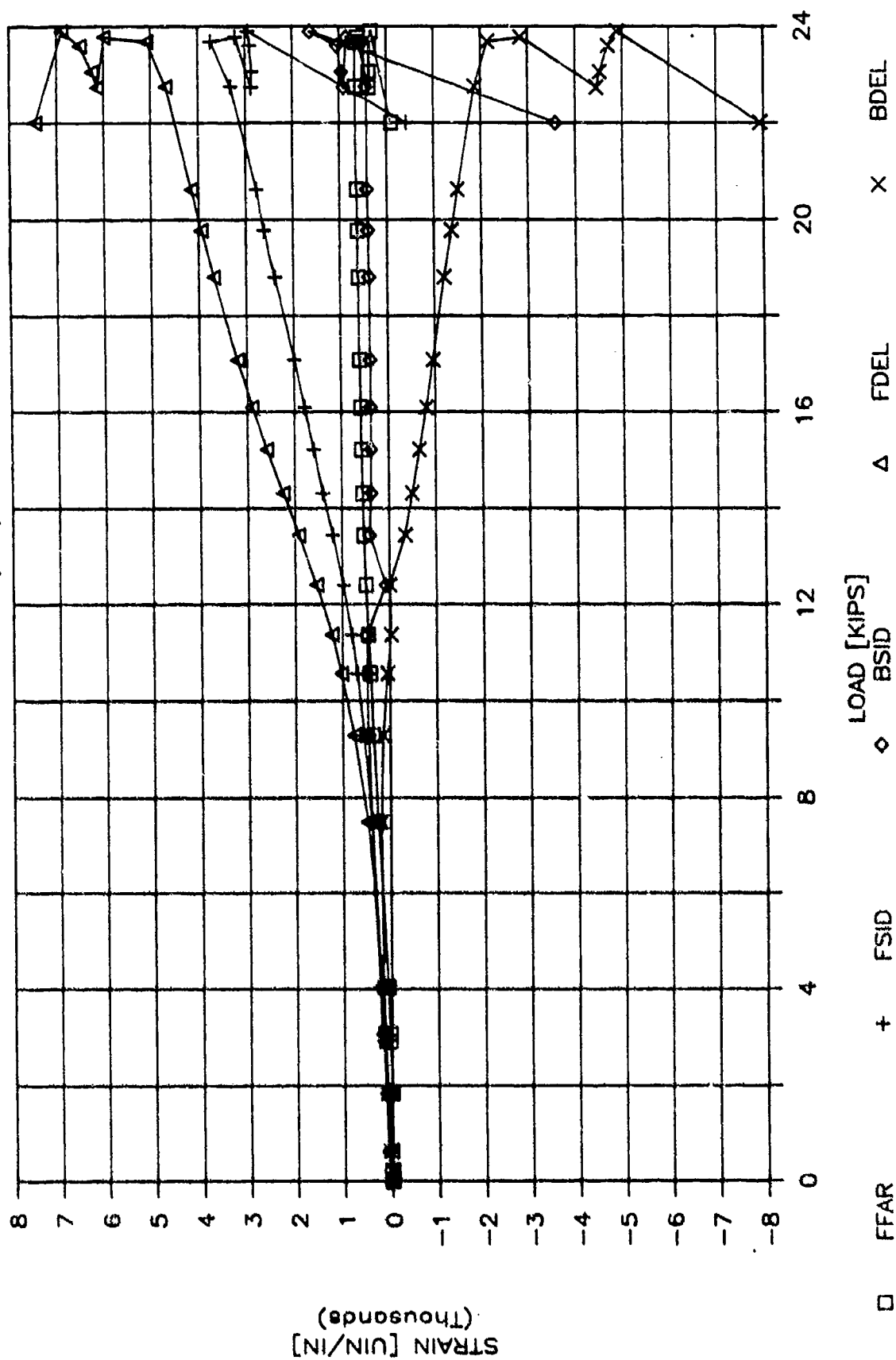


Figure B-167. Panel 2-20-7 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

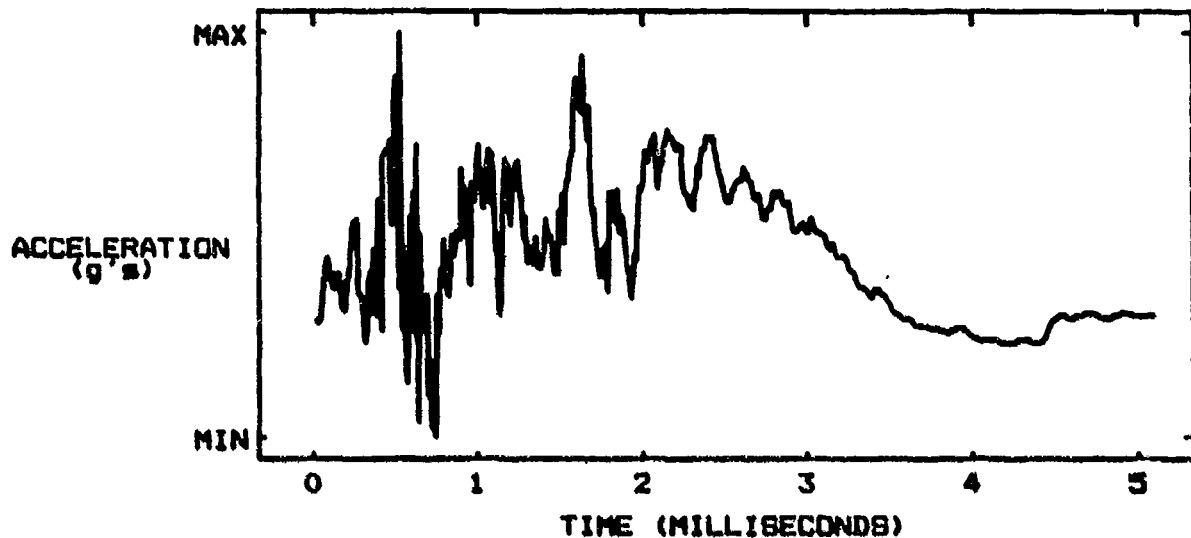
SPECIMEN I.D. 2-15-8

THICKNESS .439 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

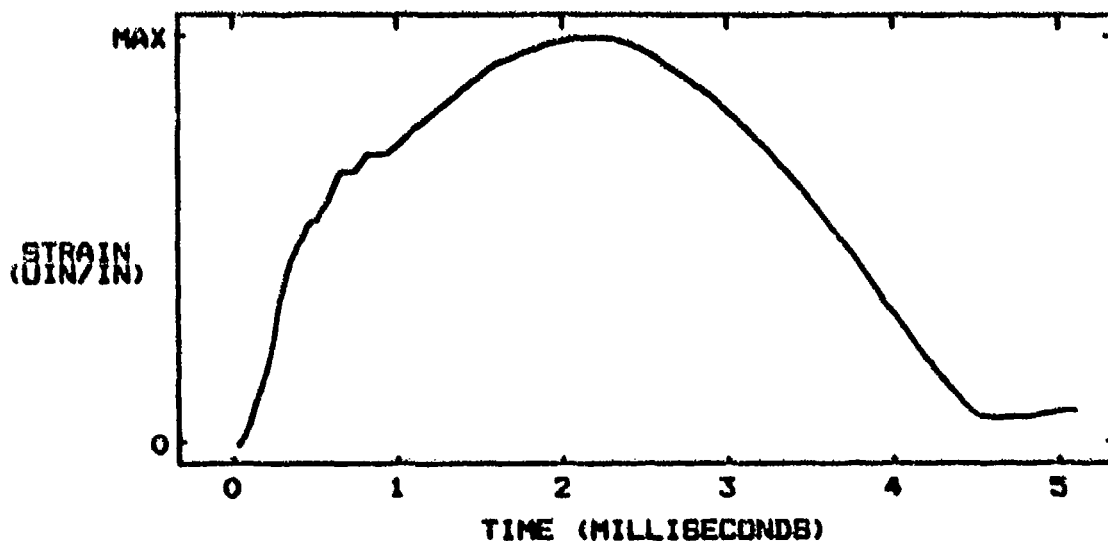
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -610 g's      MAXIMUM ACCELERATION 590 g's

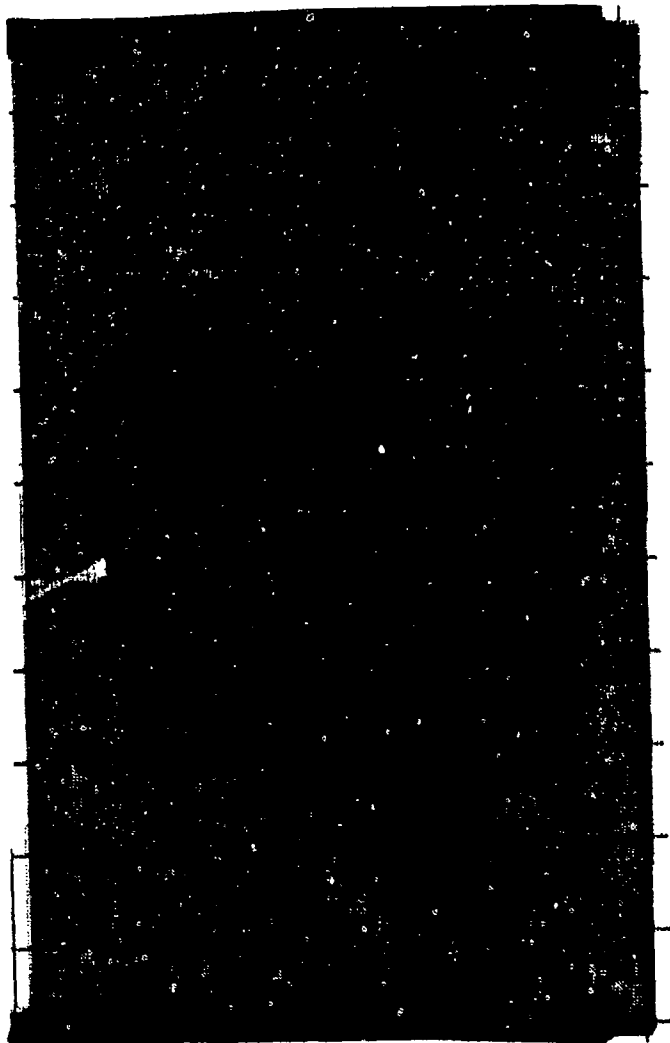
INTEGRATED TOTAL VELOCITY 256 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 13606 UIN/IN

Figure B-168. Panel 2-15-8 Impact Response Data



**Specimen 2-15-8**

**Figure B-169. Panel 2-15-8 C-Scan**

# CSAI -- IM6/F650

PANEL 2-15-8 (RTD)

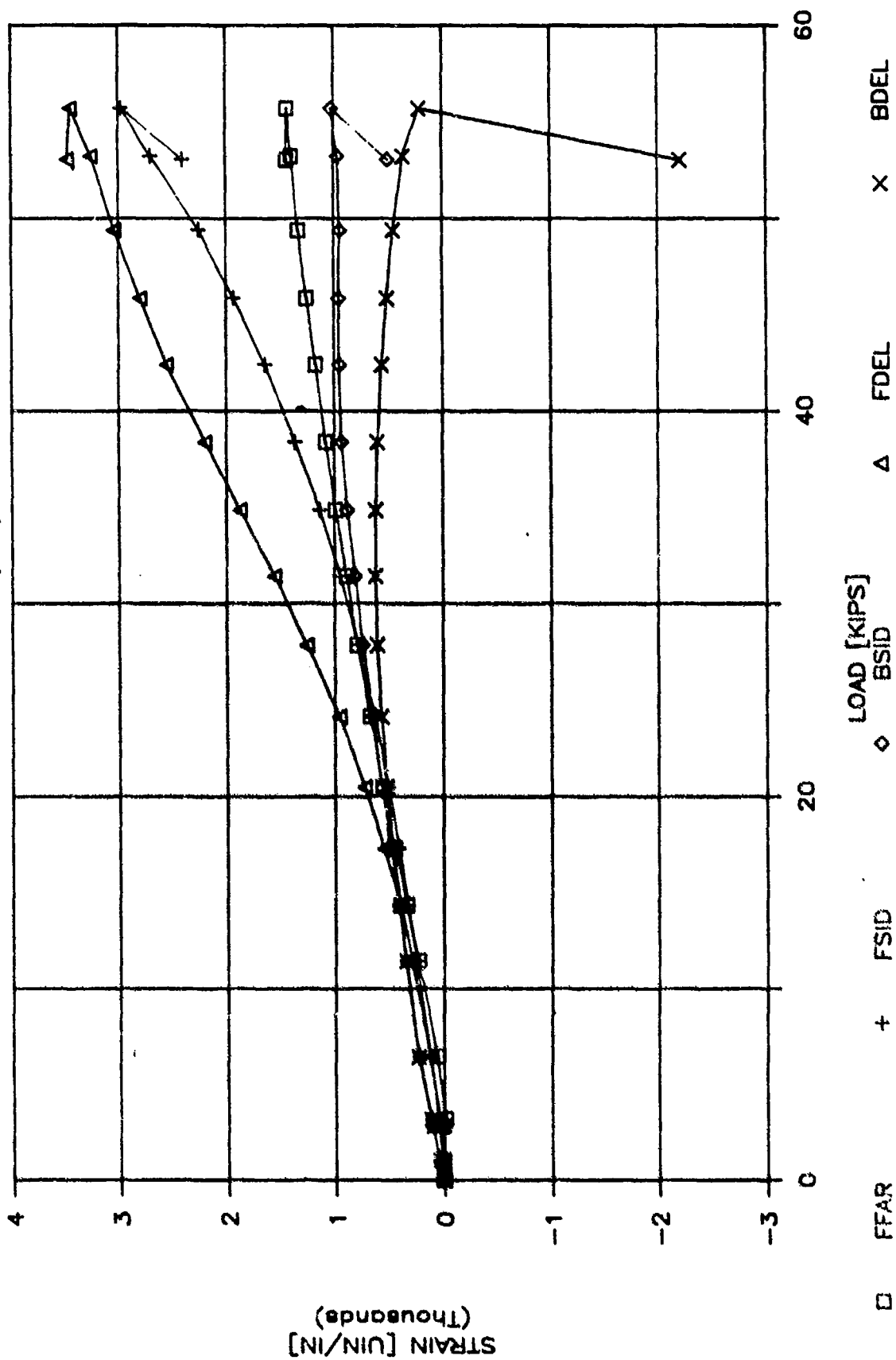


Figure B-170. Panel 2-15-8 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

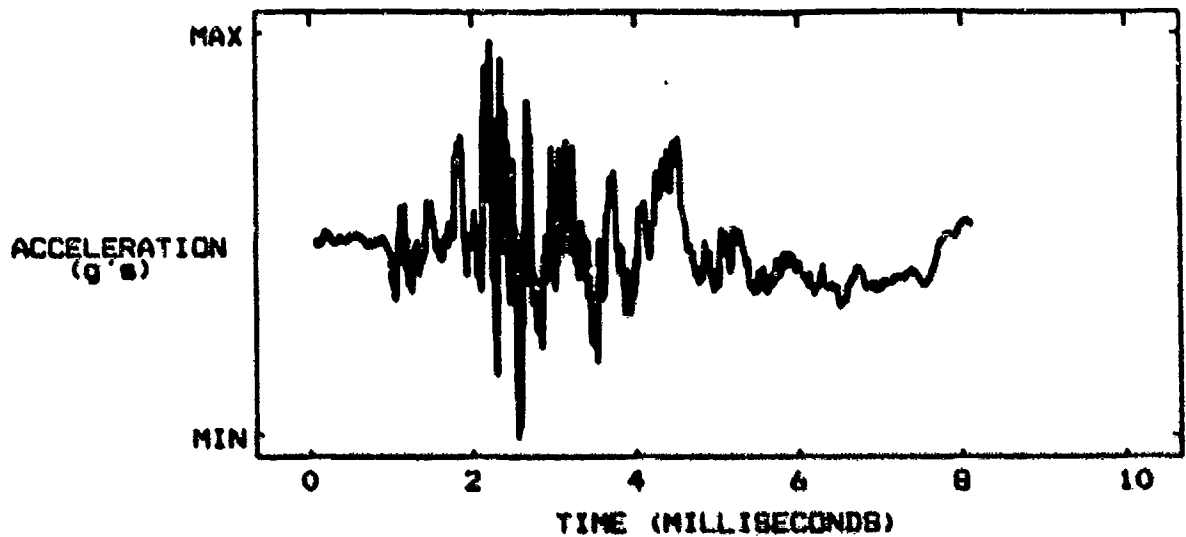
SPECIMEN I.D. 1-12-12

THICKNESS .114 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 39.3 IN

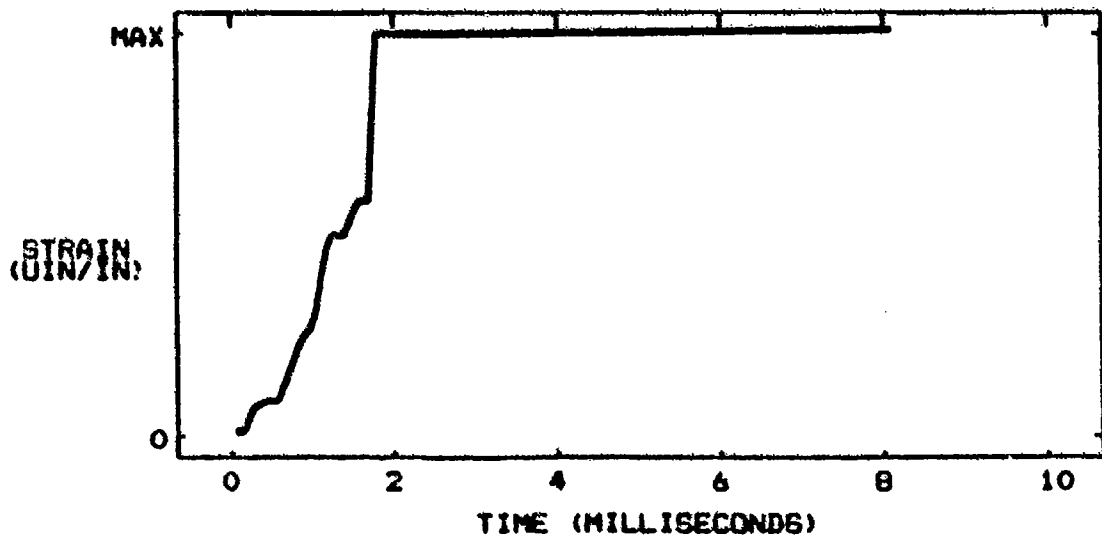
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -180 g's      MAXIMUM ACCELERATION 199.0 g's

INTEGRATED TOTAL VELOCITY 2.6016 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 36732 UIN/IN

Figure B-171. Panel 1-12-12 Impact Response Data

# CSAI - IM6/3100

PANEL 1-12-12 (ETW)

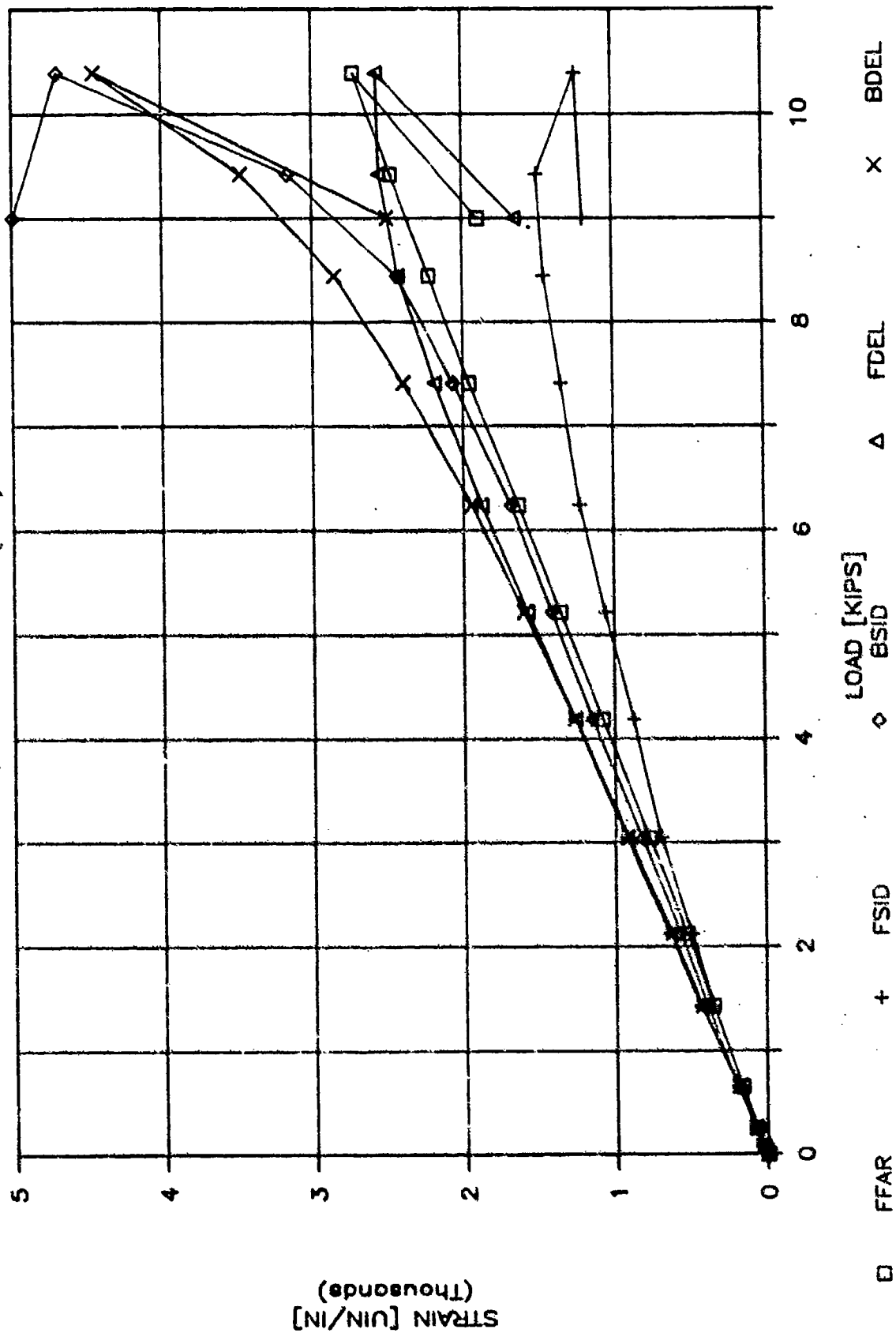


Figure B-172. Panel 1-12-12 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

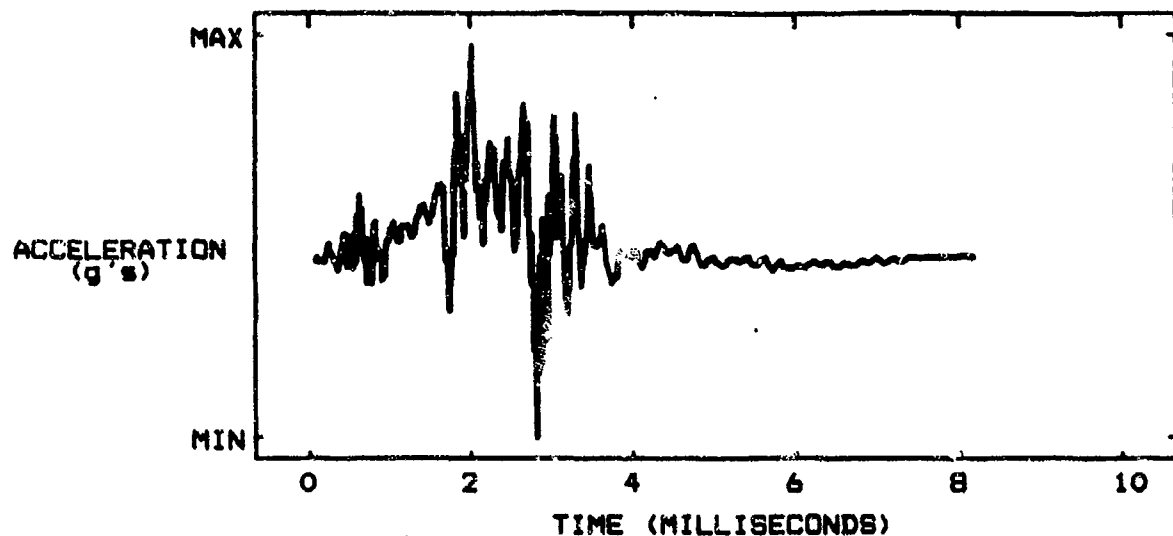
SPECIMEN I.D. 1-11-12

THICKNESS .223 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

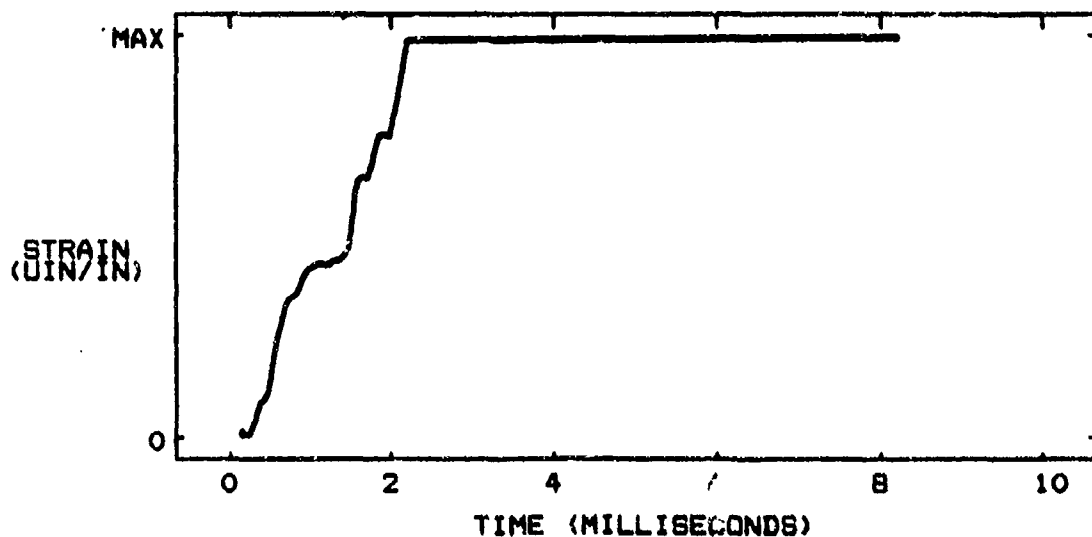
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -435 g's      MAXIMUM ACCELERATION 558.59 g's

INTEGRATED TOTAL VELOCITY 149.99 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 36545 UIN/IN

Figure B-173. Panel 1-11-12 Impact Response Data

# CSAI - IM6/3100

PANEL 1-11-12 (ETW)

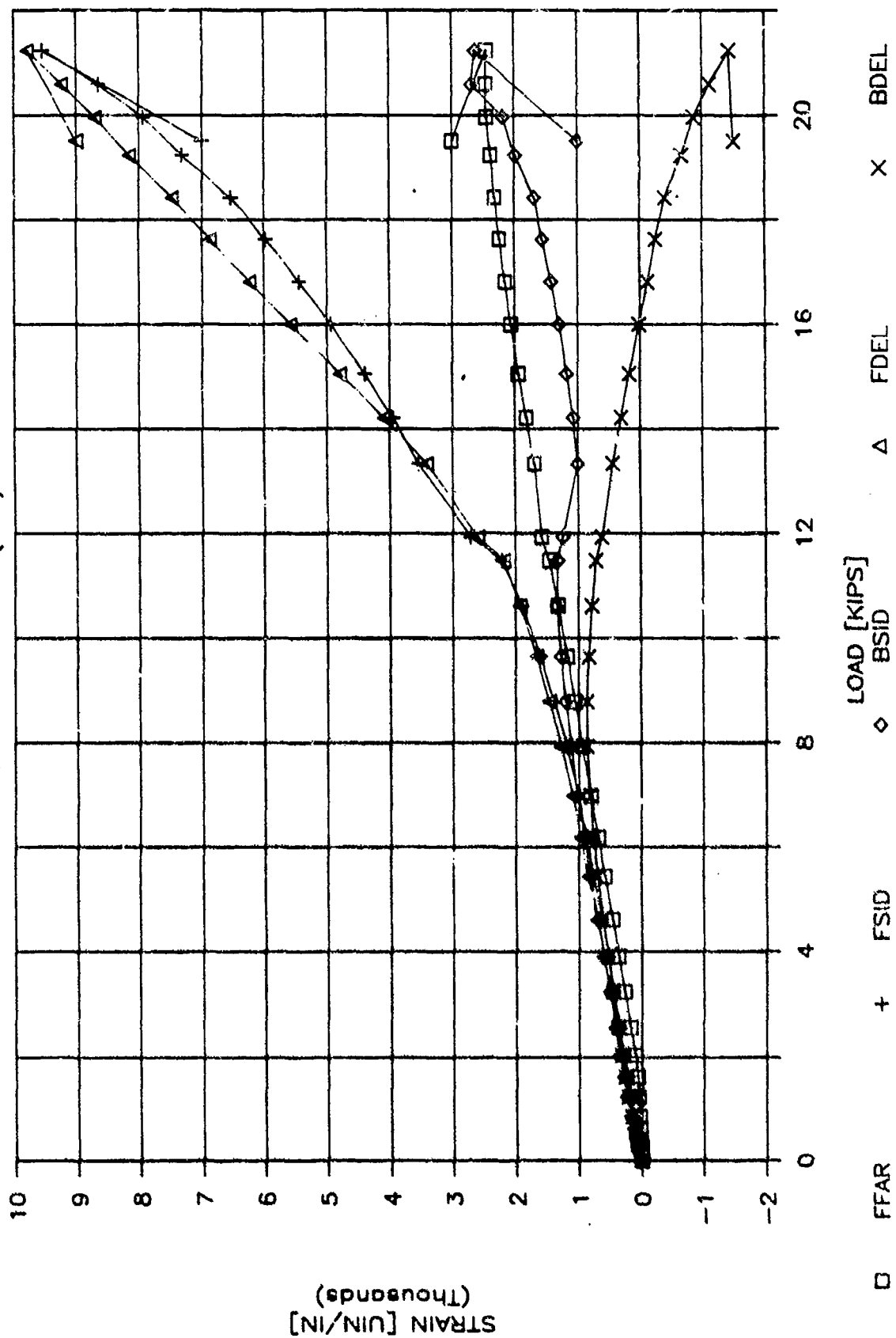


Figure B-174. Panel 1-11-12 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

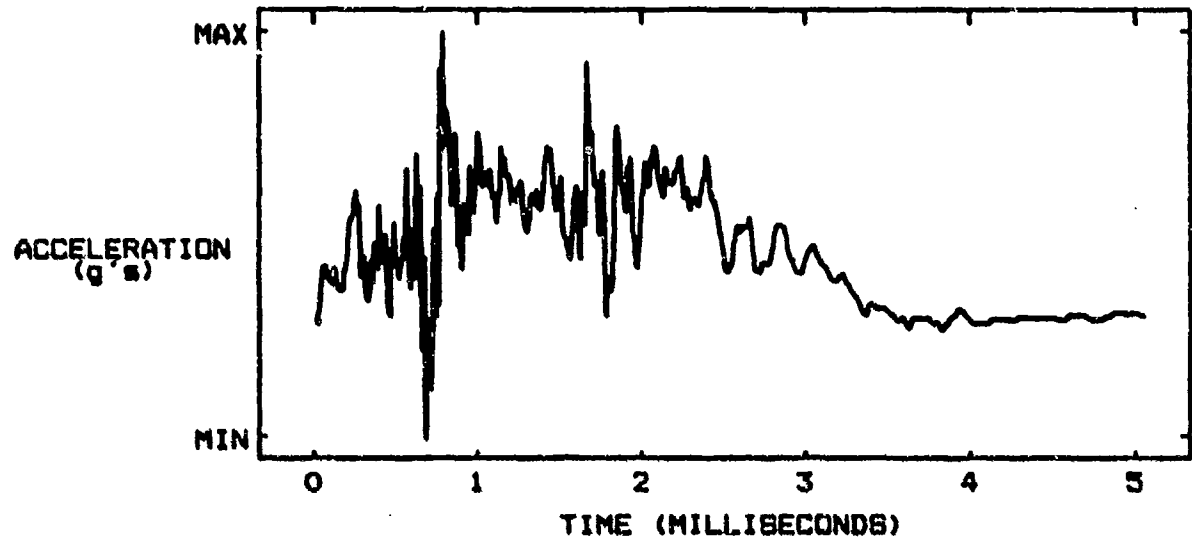
SPECIMEN I.D. 1-13-12

THICKNESS .452 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

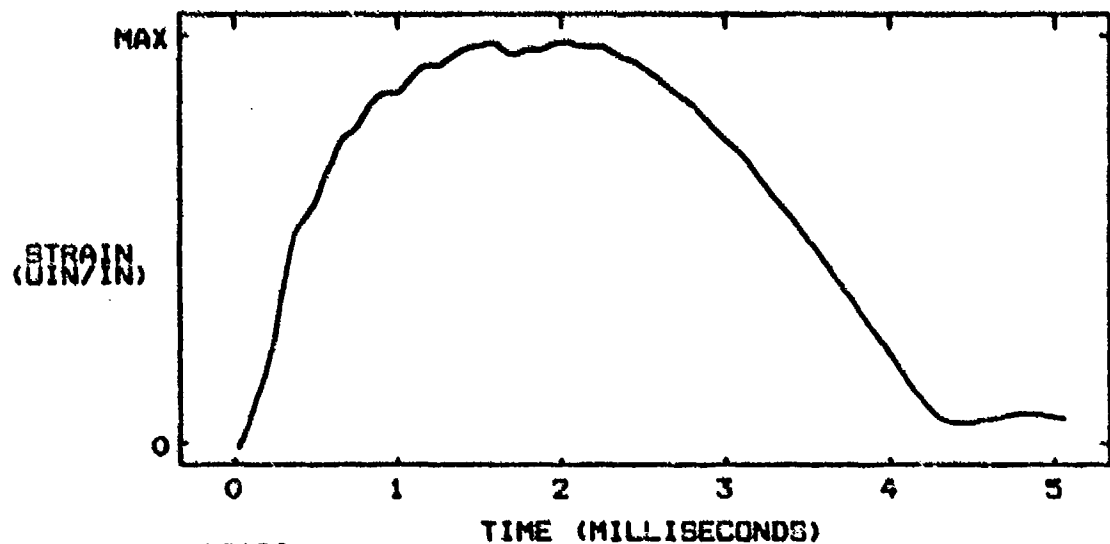
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -300 g's      MAXIMUM ACCELERATION 752 g's

INTEGRATED TOTAL VELOCITY 323.14 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 17073 IN/IN

Figure B-175. Panel 1-13-12 Impact Response Data

# CSAI - IM6/3100

PANEL 1-13-12 (ETW)

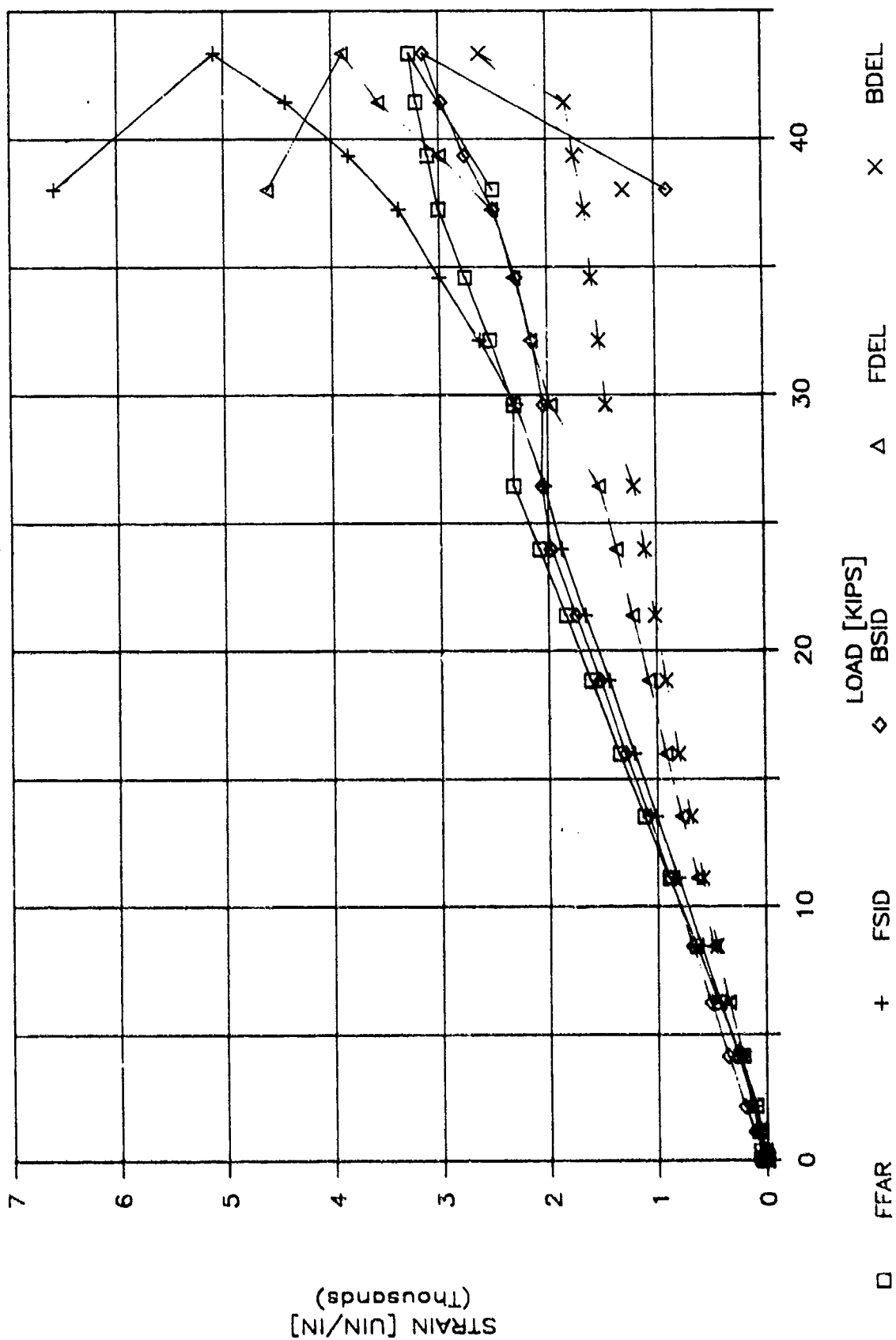


Figure B-176. Panel 1-13-12 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

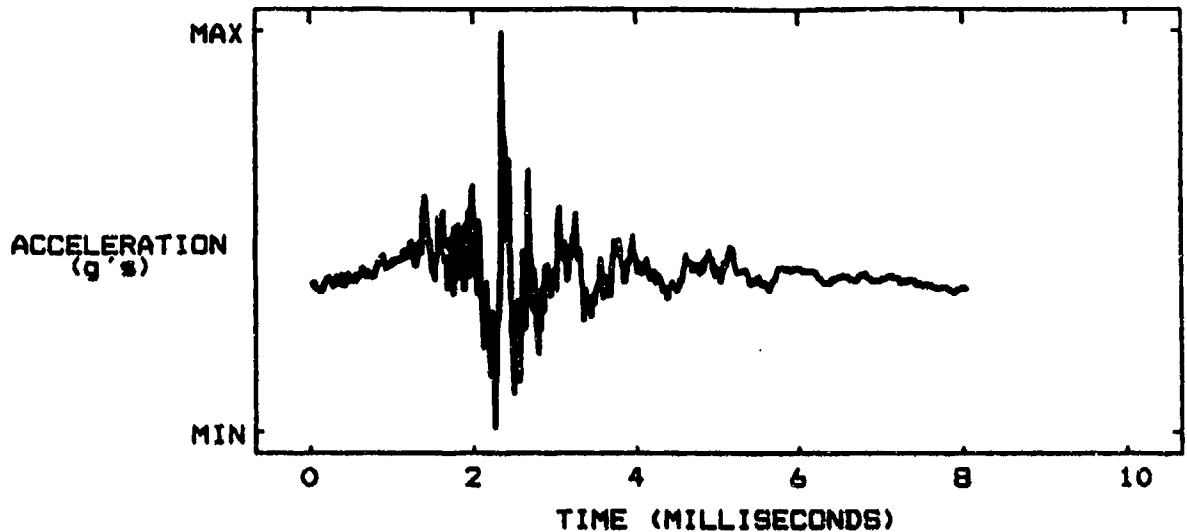
SPECIMEN I.D. 1-14-11

THICKNESS .109 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 38.2 IN

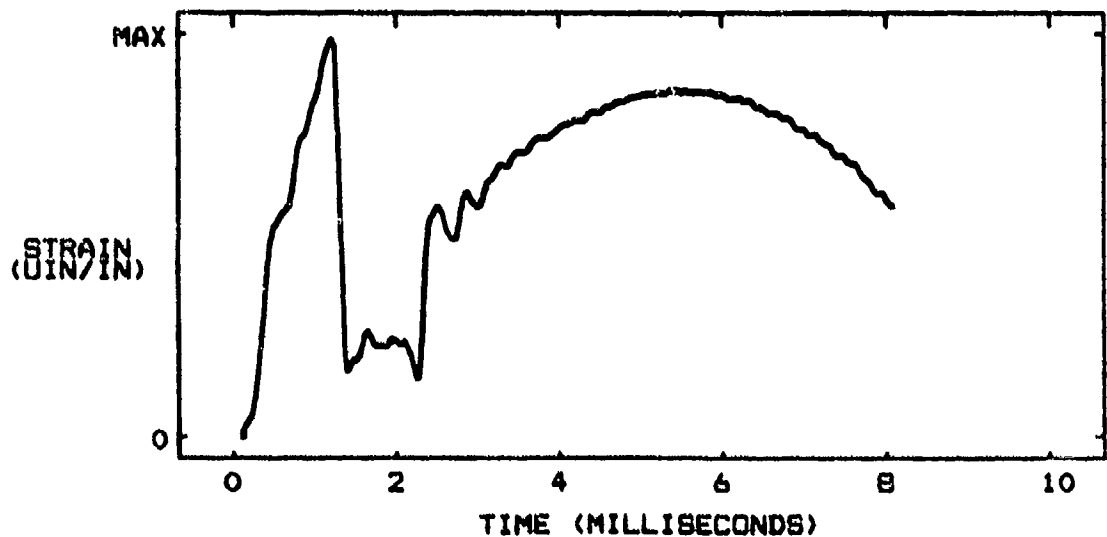
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -415 g's      MAXIMUM ACCELERATION 701.17 g's

INTEGRATED TOTAL VELOCITY 50.093 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 10729 UIN/IN

Figure B-177. Panel 1-14-11 Impact Response Data

# CSAI -- IM6/3100

PANEL 1-14-11 (ETW)

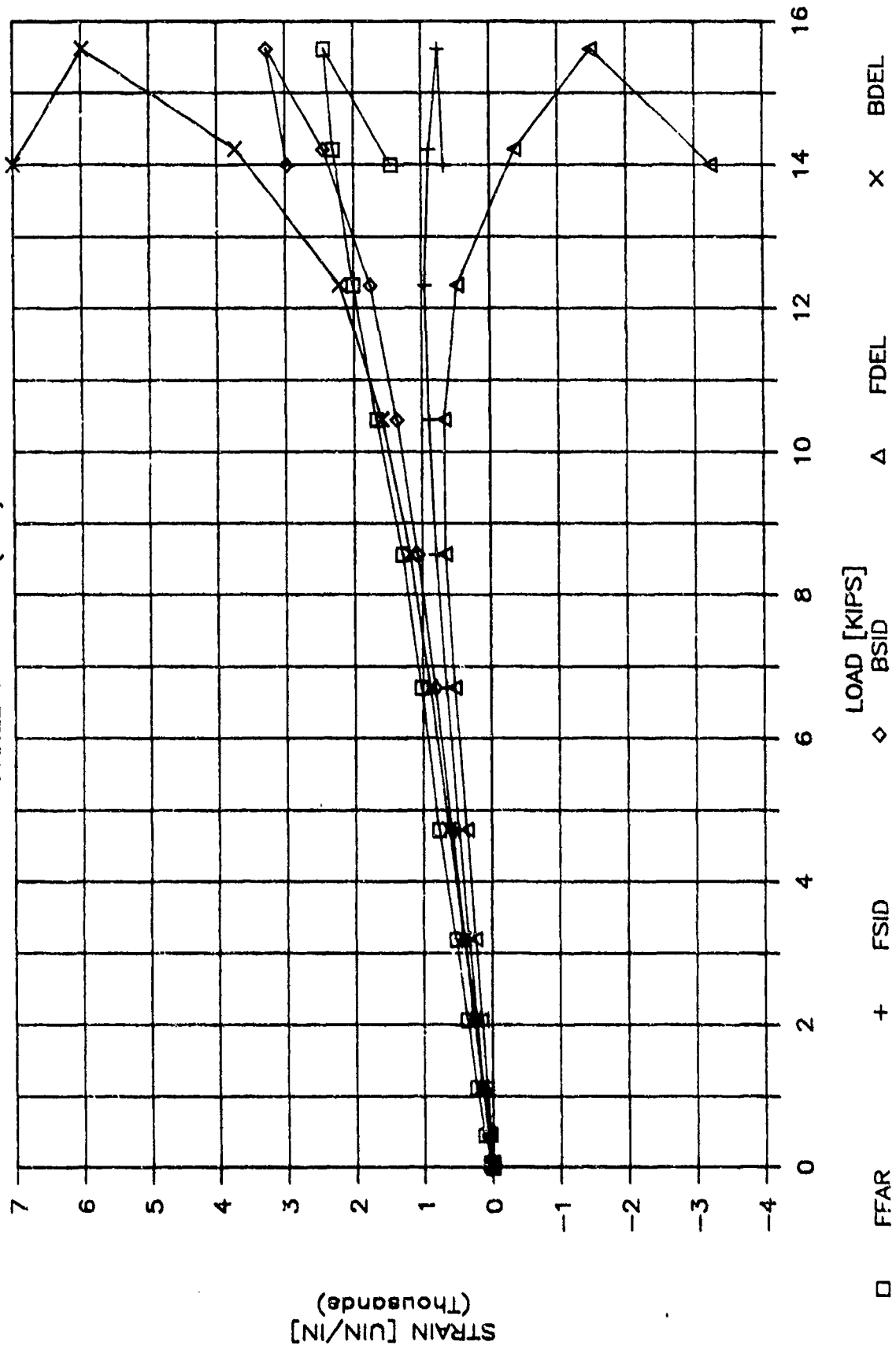


Figure B-178. Panel 1-14-11 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/3100

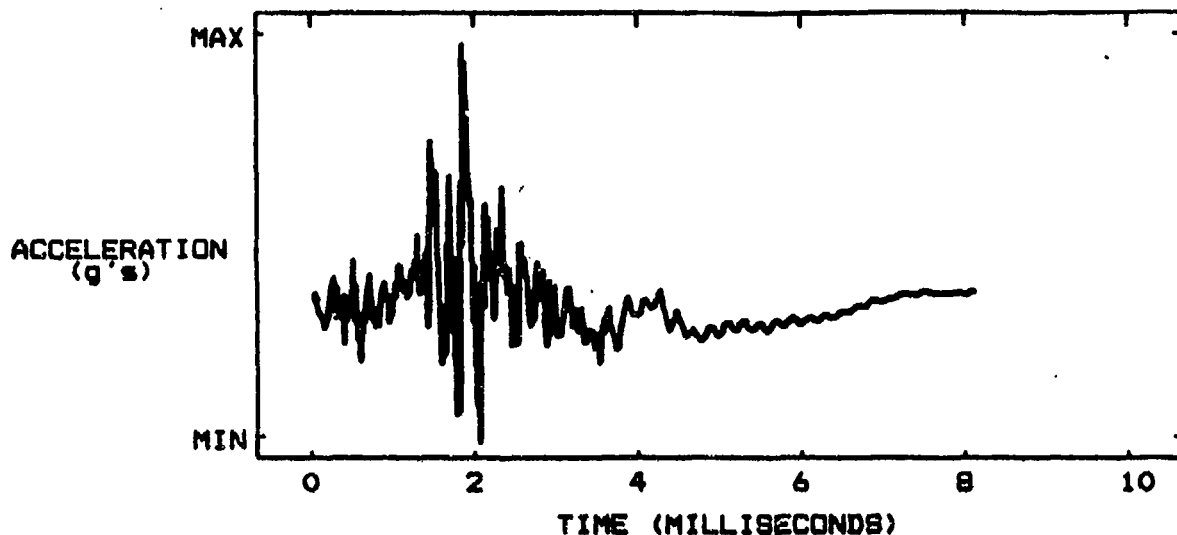
SPECIMEN I.D. 1-20-11

THICKNESS .225 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

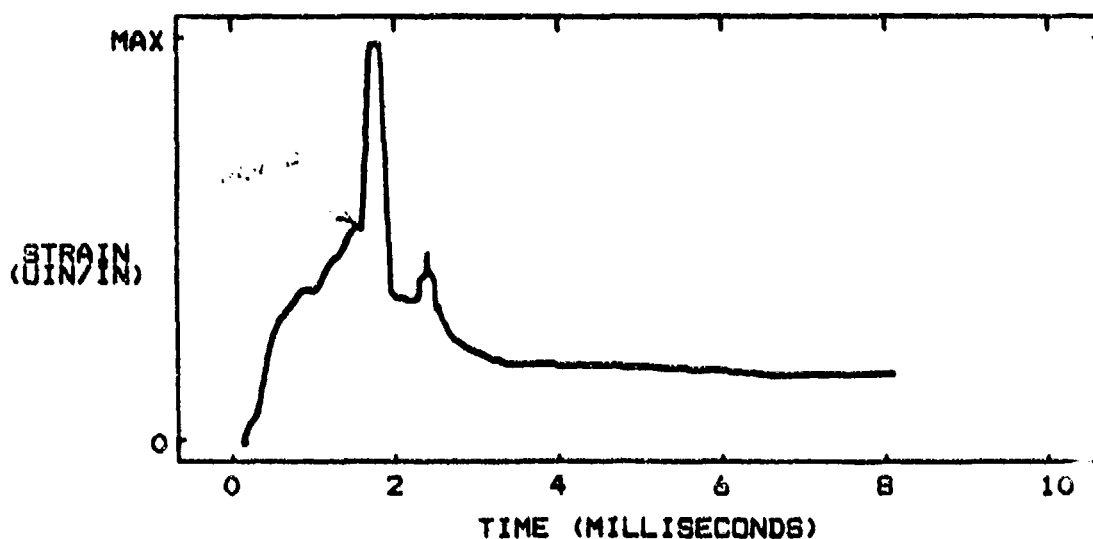
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -330 g's      MAXIMUM ACCELERATION 617.19 g's

INTEGRATED TOTAL VELOCITY -61.751 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 19829 UIN/IN

Figure B-179. Panel 1-20-11 Impact Response Data

# CSAI - IM6/3100

PANEL 1-20-11 (ETW)

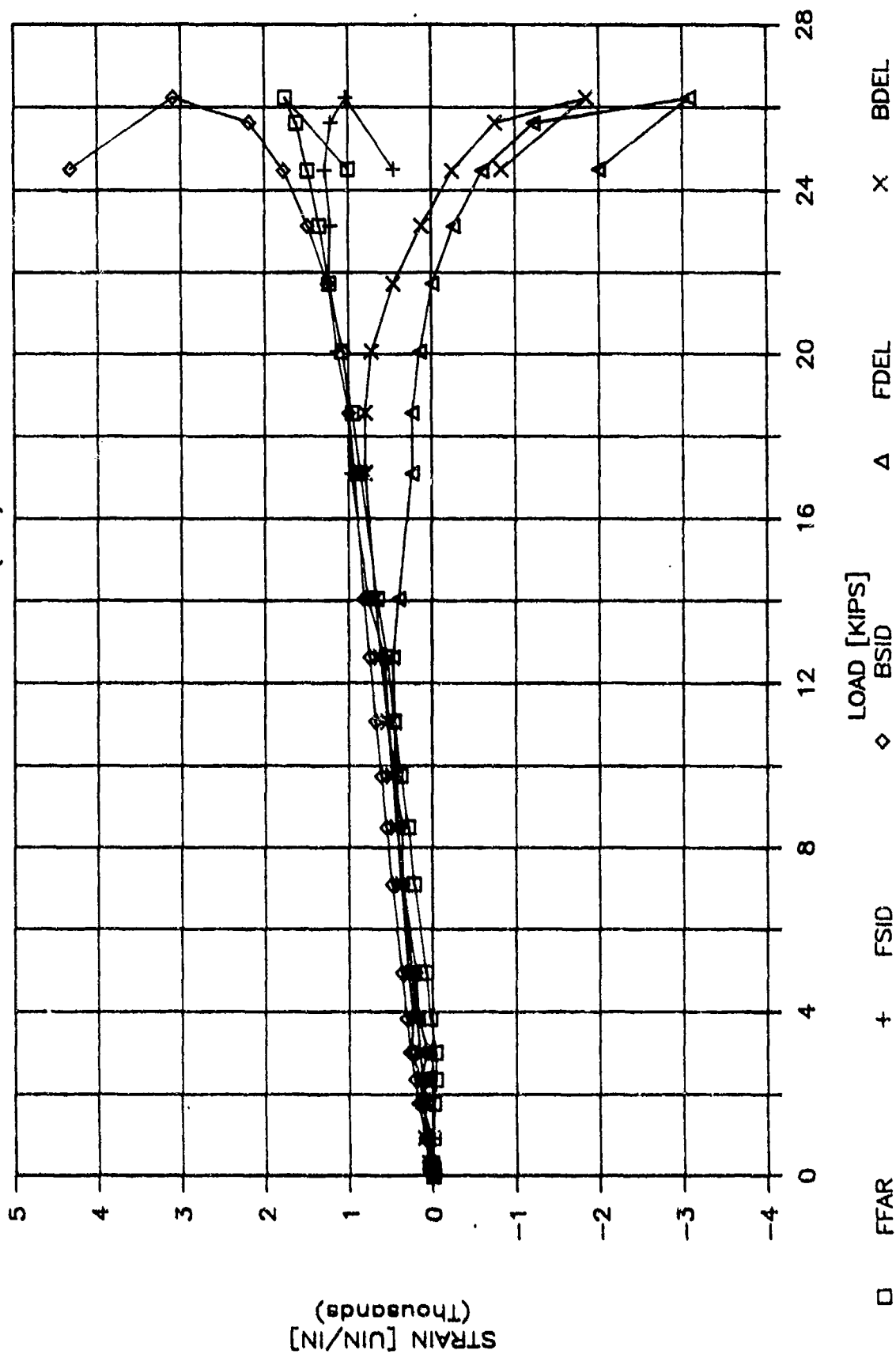


Figure B-180. Panel 1-20-11 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

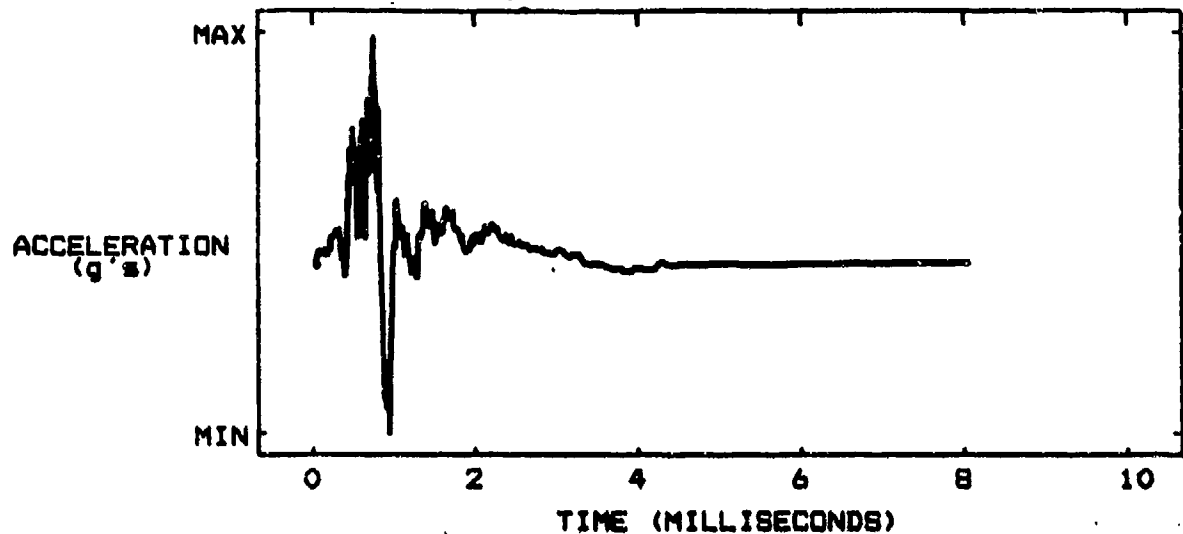
SPECIMEN I.D. 1-15-11

THICKNESS .452 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

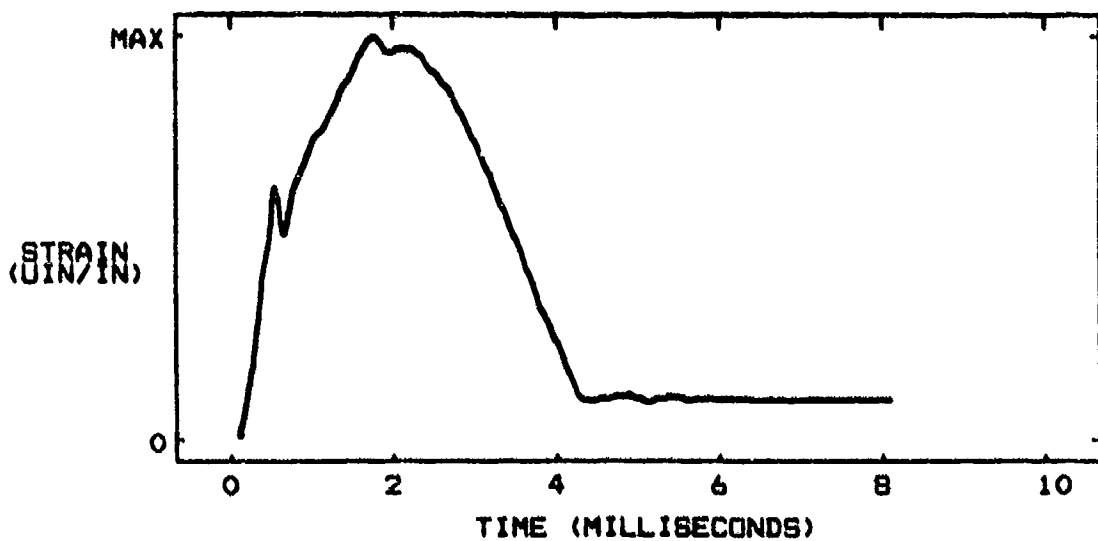
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -1450 g's      MAXIMUM ACCELERATION 1927.7 g's

INTEGRATED TOTAL VELOCITY 269.12 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 14299 IN/IN

Figure B-181. Panel 1-15-11 Impact Response Data

# CSAI - IM6/3100

PANEL 1-15-11 (ETW)

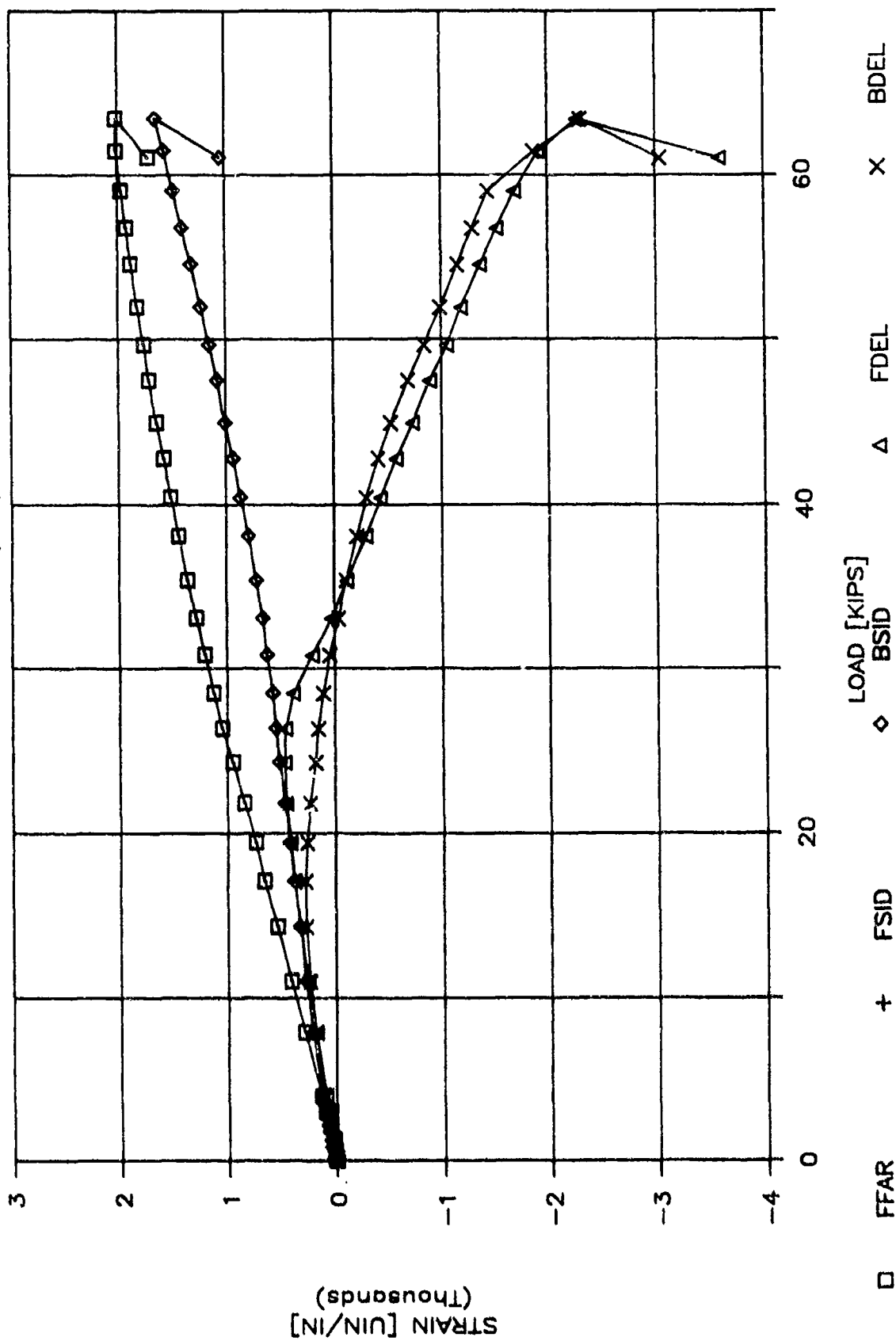


Figure B-182. Panel 1-15-11 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

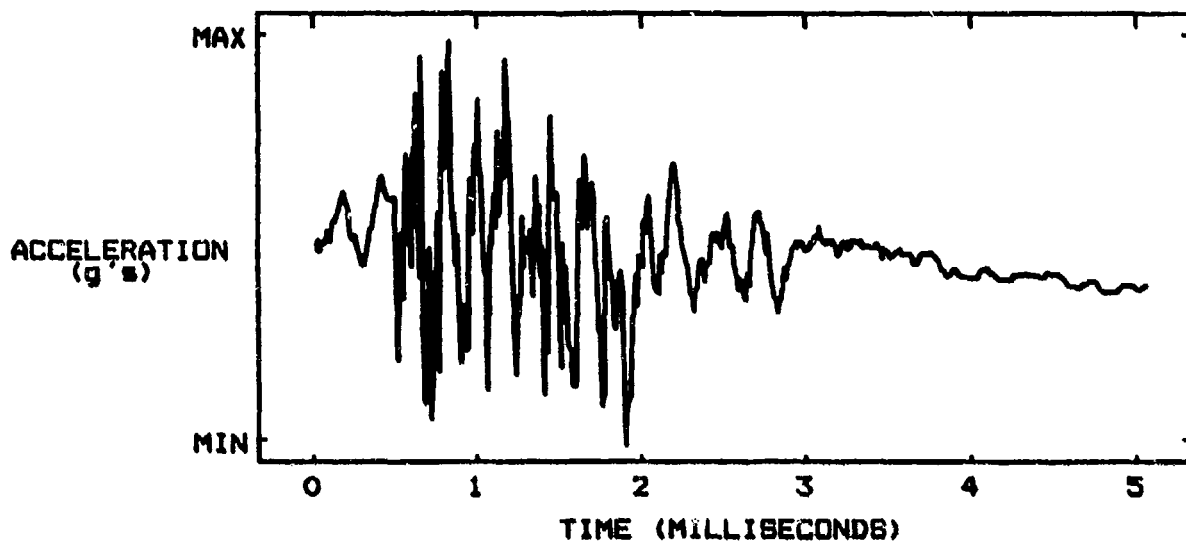
SPECIMEN I.D. 2-12-11

THICKNESS 106 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 29.5 IN

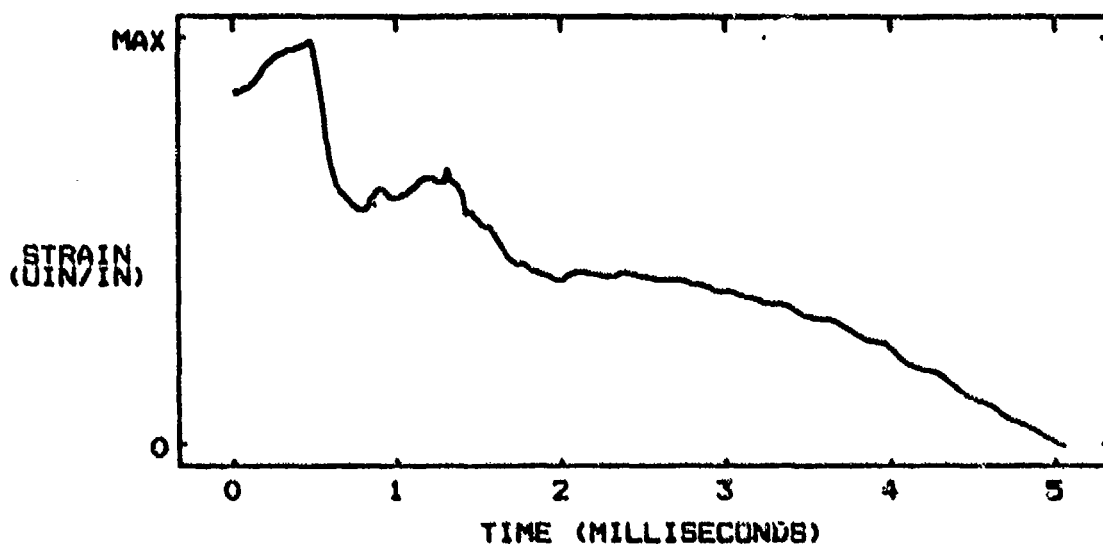
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -179 g's      MAXIMUM ACCELERATION 242.00 g's

INTEGRATED TOTAL VELOCITY -319.42 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 17303 UIN/IN

Figure B-183. Panel 2-12-11 Impact Response Data

# CSAI - IM6/F650

PANEL 2-12-11 (ETW)

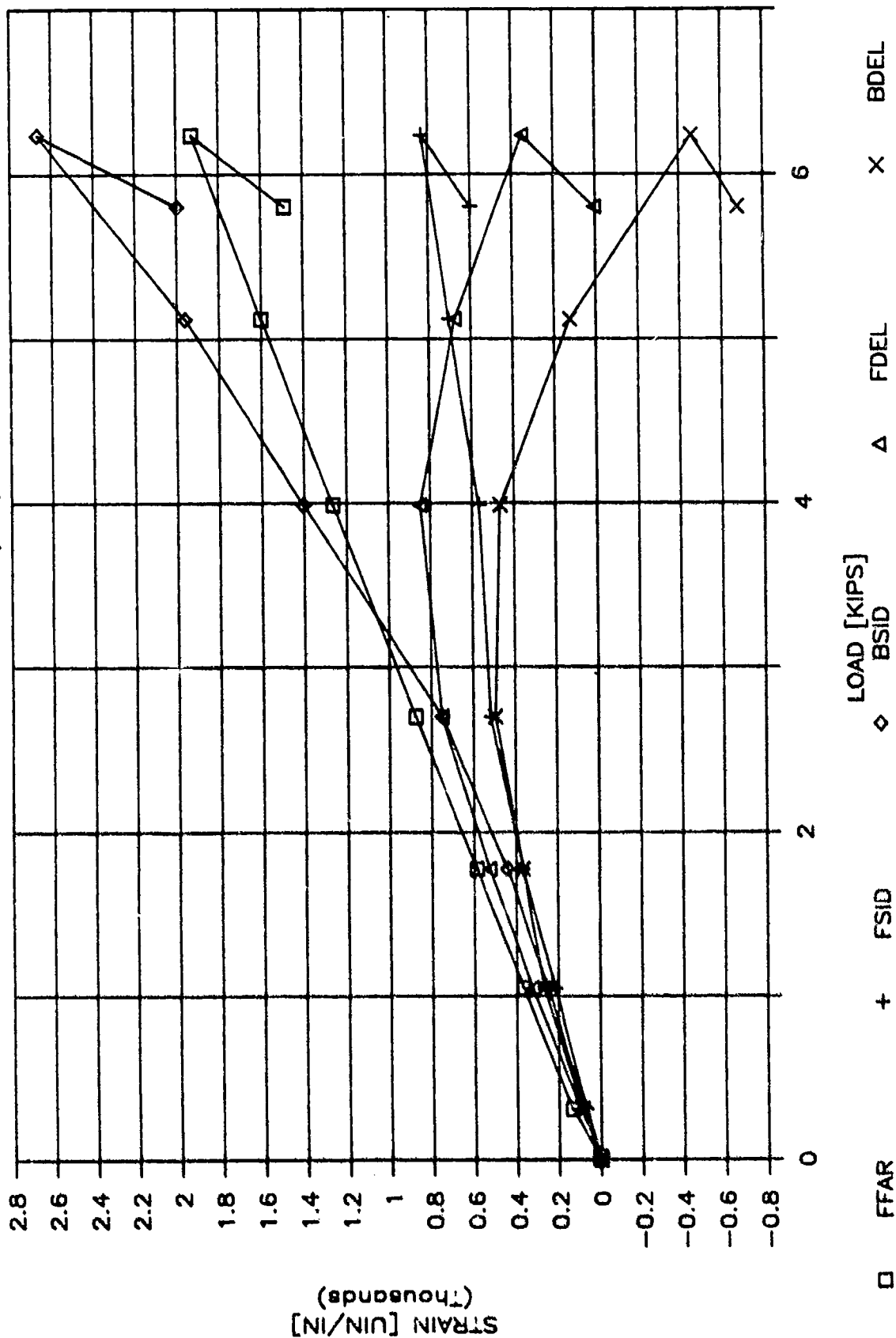


Figure B-184. Panel 2-12-11 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

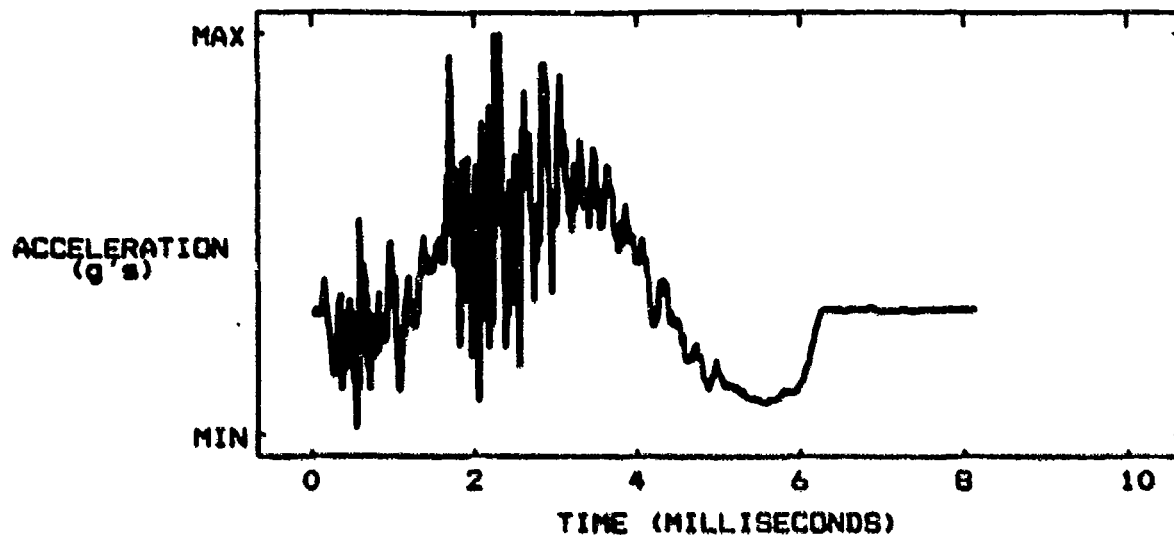
SPECIMEN I.D. 2-11-11

THICKNESS .217 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

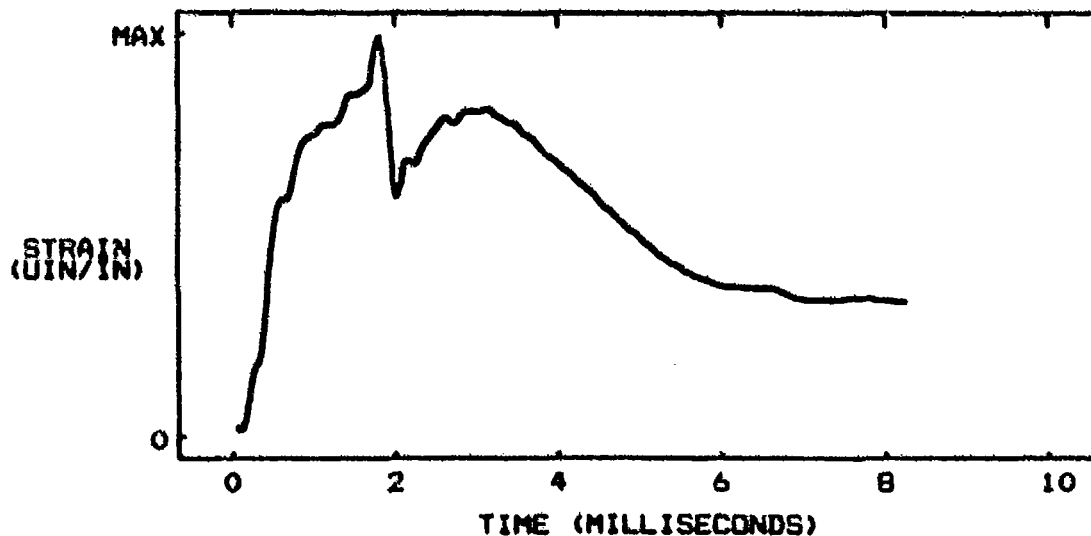
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -97 g's      MAXIMUM ACCELERATION 222.00 g's

INTEGRATED TOTAL VELOCITY 60.749 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 20090 UIN/IN

Figure B-185. Panel 2-11-11 Impact Response Data

# CSA1 - IM6/F650

PANEL 2-11-11 (ETW)

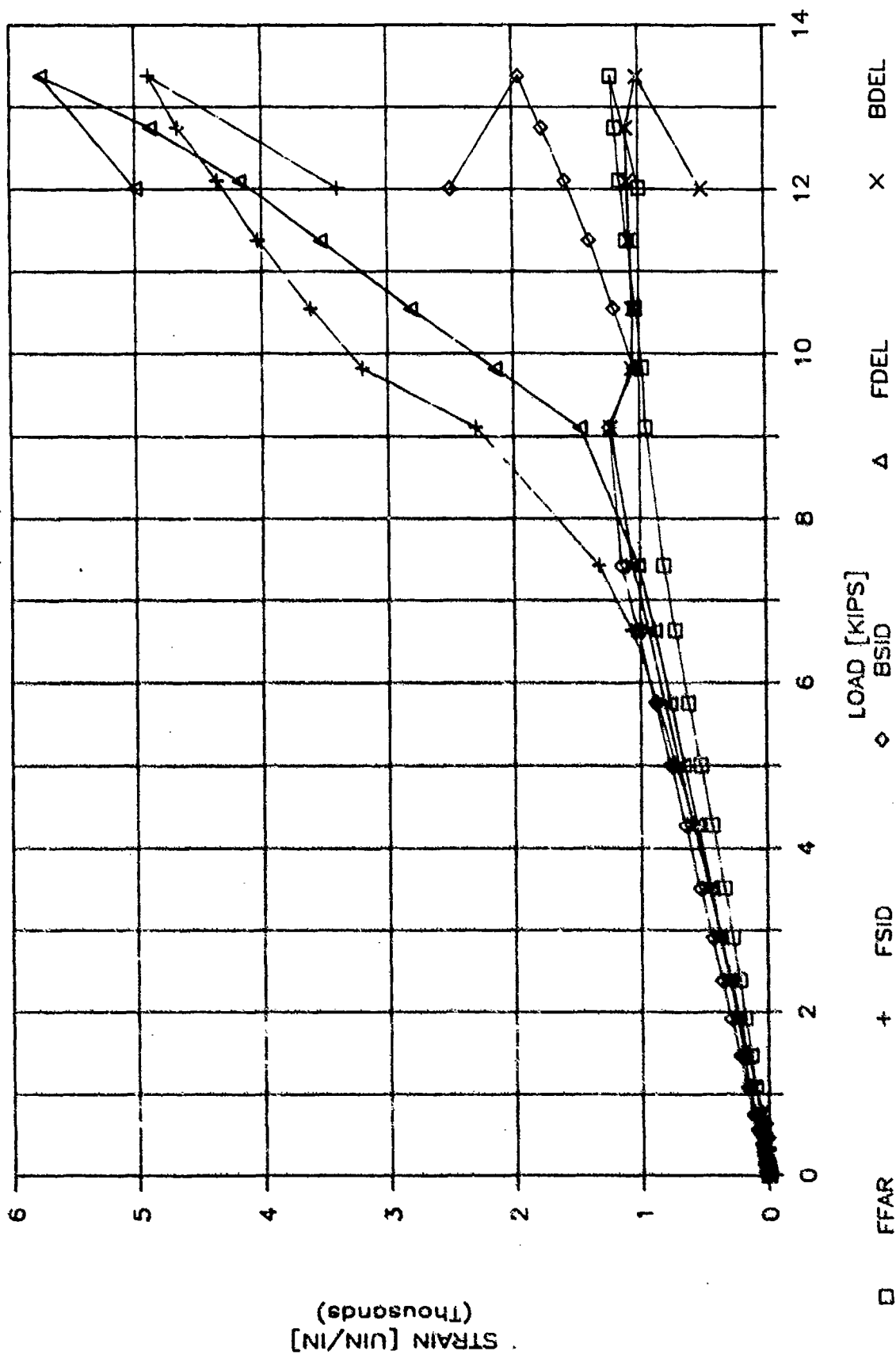


Figure 8-186. Panel 2-11-11 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

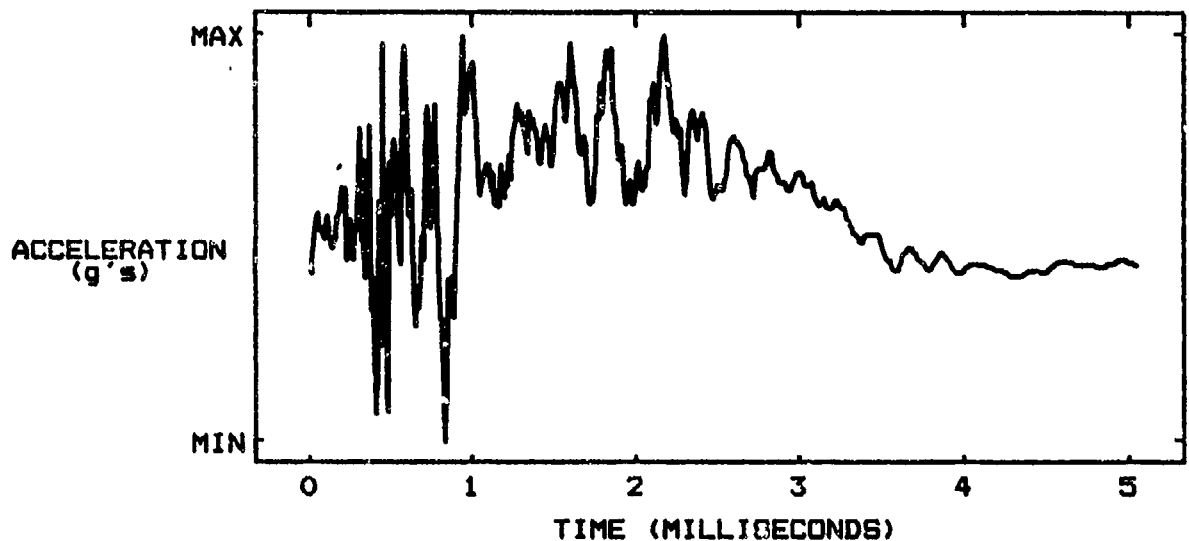
SPECIMEN I.D. 2-13-11

THICKNESS .437 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

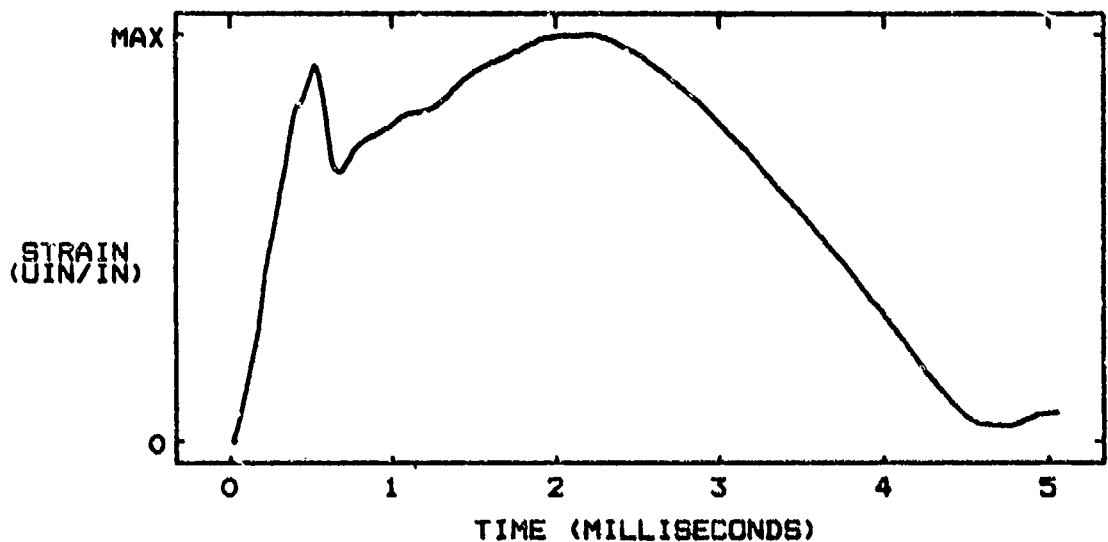
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -702.7 g's      MAXIMUM ACCELERATION 420 g's

INTEGRATED TOTAL VELOCITY 273.73 IN/SEC

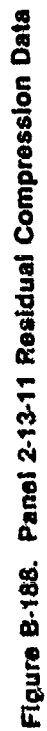
### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 12237 UIN/IN

Figure B-187. Panel 2-13-11 Impact Response Data

PANEL 2-13-11 (ETW)



## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

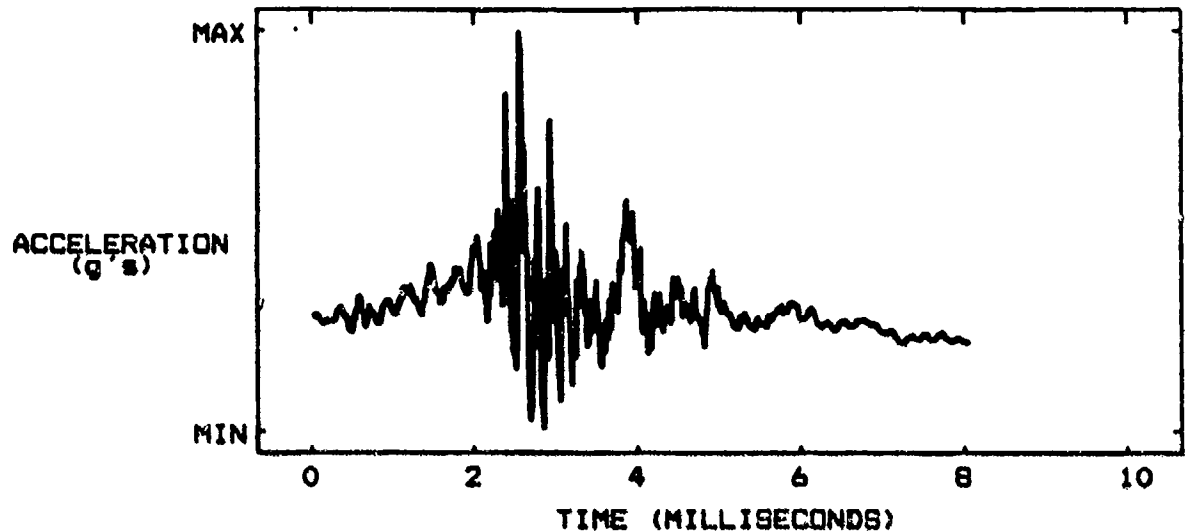
SPECIMEN I.D. 2-14-11

THICKNESS .110 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 38.2 IN

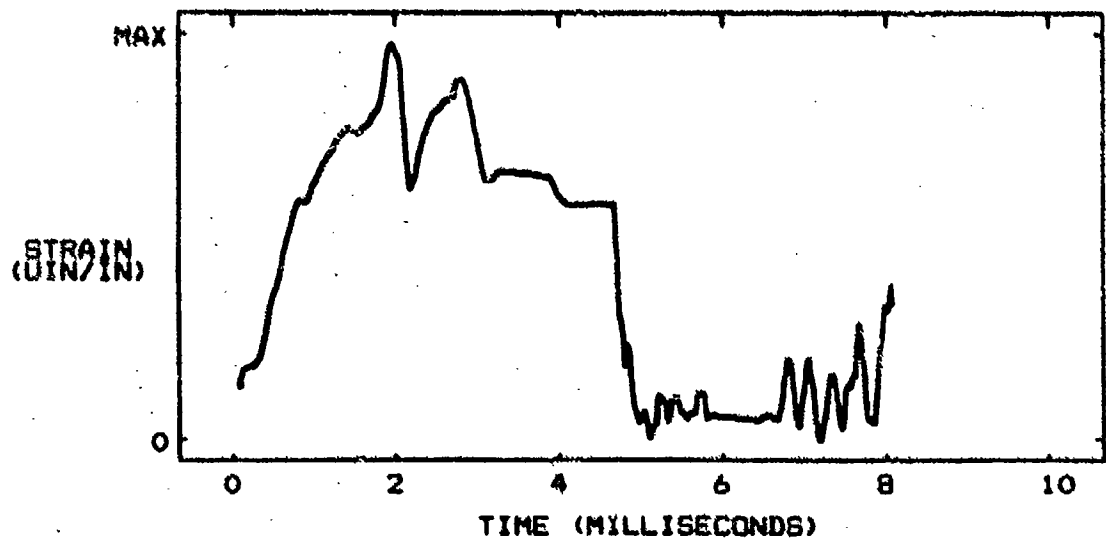
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -172 g's      MAXIMUM ACCELERATION 430.009 g's

INTEGRATED TOTAL VELOCITY 33.010 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 17185 UIN/IN

Figure B-189, Panel 2-14-11 Impact Response Data

# CSAI - IM6/F650

PANEL 2-14-11 (ETW)

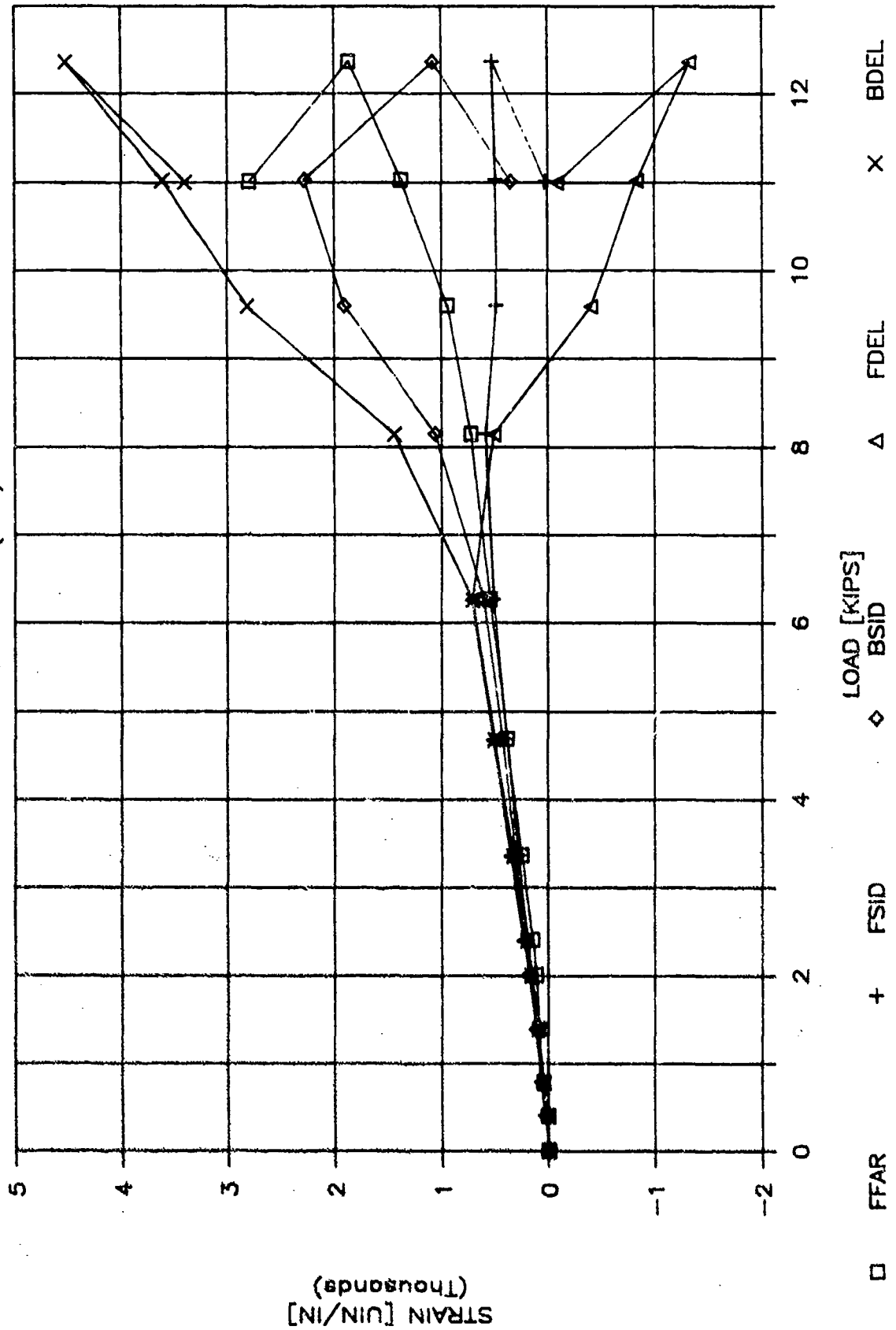


Figure B-190. Panel 2-14-11 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

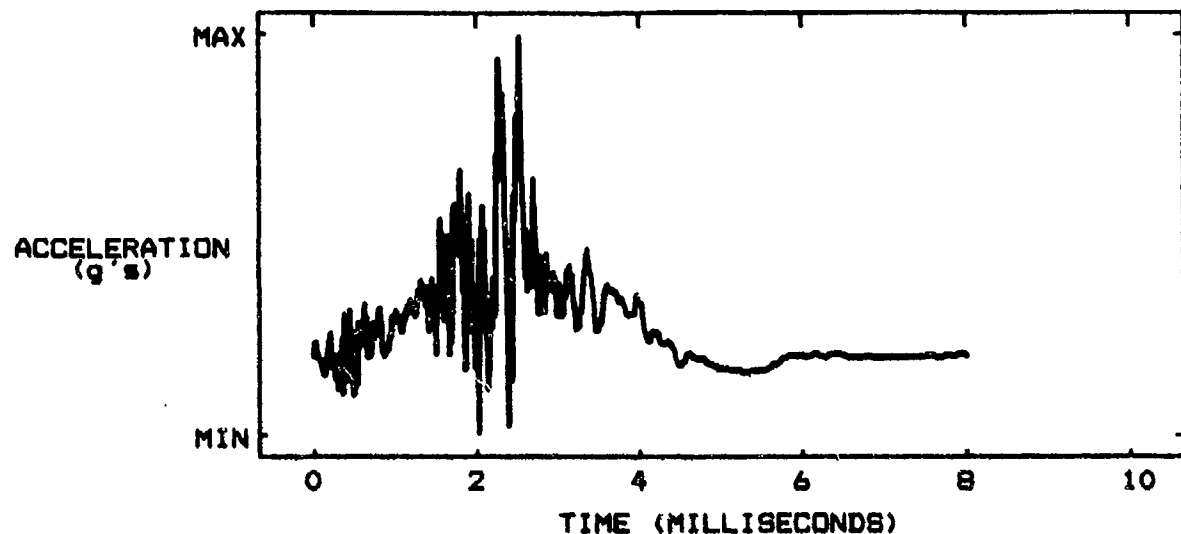
SPECIMEN I.D. 2-20-12

THICKNESS .216 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

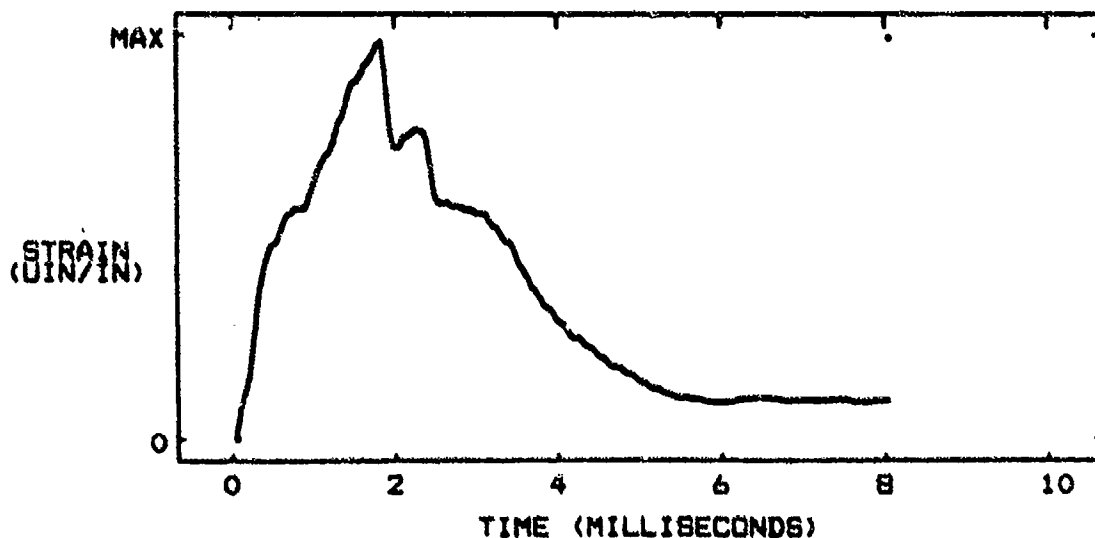
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -165 g's      MAXIMUM ACCELERATION 701.17 g's

INTEGRATED TOTAL VELOCITY 182.59 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 17288 UIN/IN

Figure B-191. Panel 2-20-12 Impact Response Data

# CSA1 - IM6/F650

PANEL 2-20-12 (ETW)

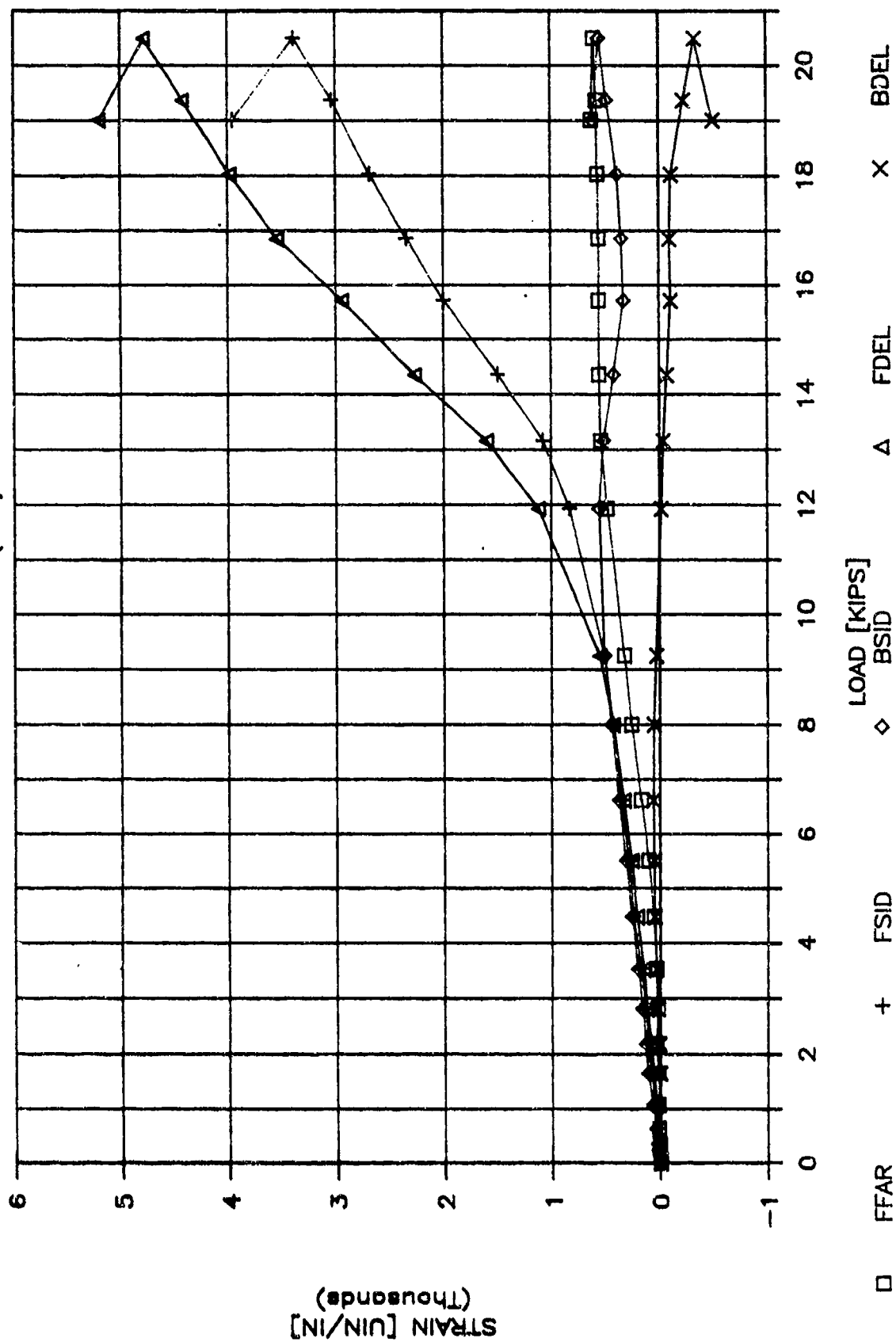


Figure B-192. Panel 2-20-12 Residual Compression Data

## LVID SPECIMEN DATA

MATERIAL SYSTEM IM6/F650

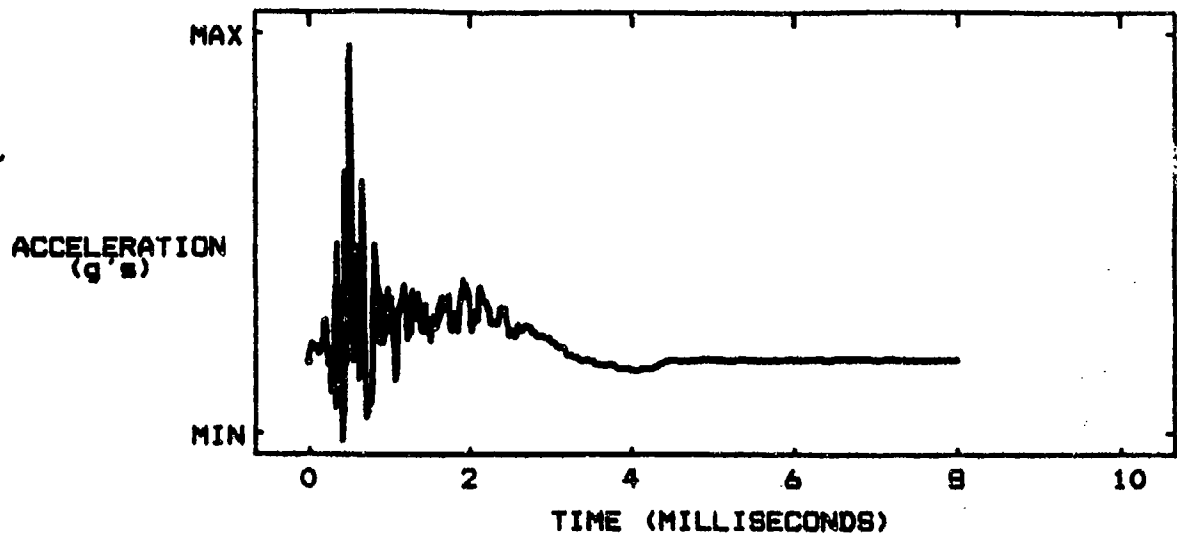
SPECIMEN I.D. 2-15-10

THICKNESS .440 IN

DROP CARRIAGE WT. 19.47 LBS

DROP HEIGHT 65.6 IN

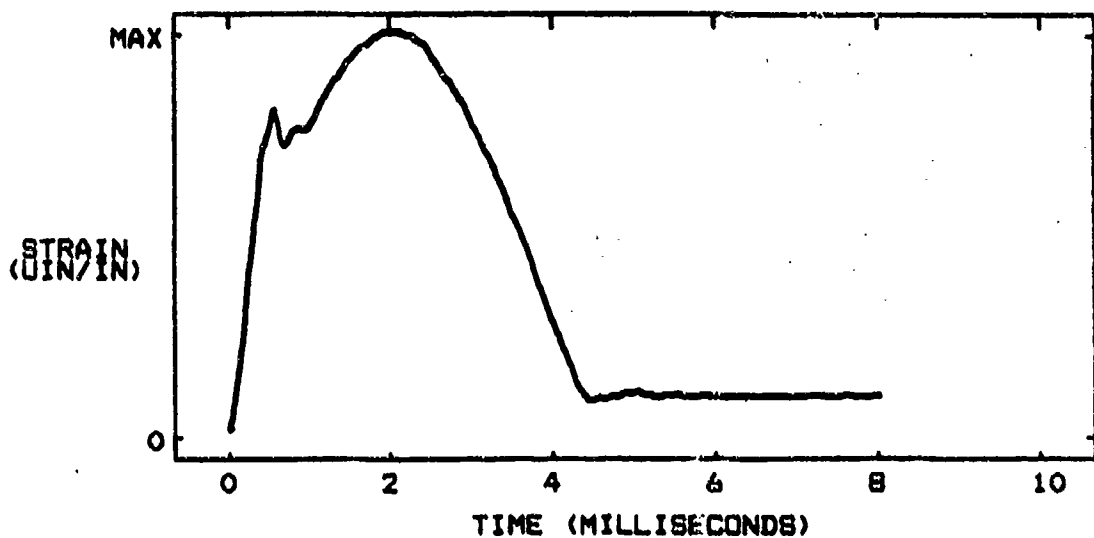
### ACCELERATION VERSUS TIME



MINIMUM ACCELERATION -38 g's      MAXIMUM ACCELERATION 181.00 g's

INTEGRATED TOTAL VELOCITY -3.0295 IN/SEC

### PANEL STRAIN VERSUS TIME



MAXIMUM STRAIN 12406 UIN/IN

Figure B-193. Panel 2-15-10 Impact Response Data

# CSAI - IM6/F650

PANEL 2-15-10 (ETW)

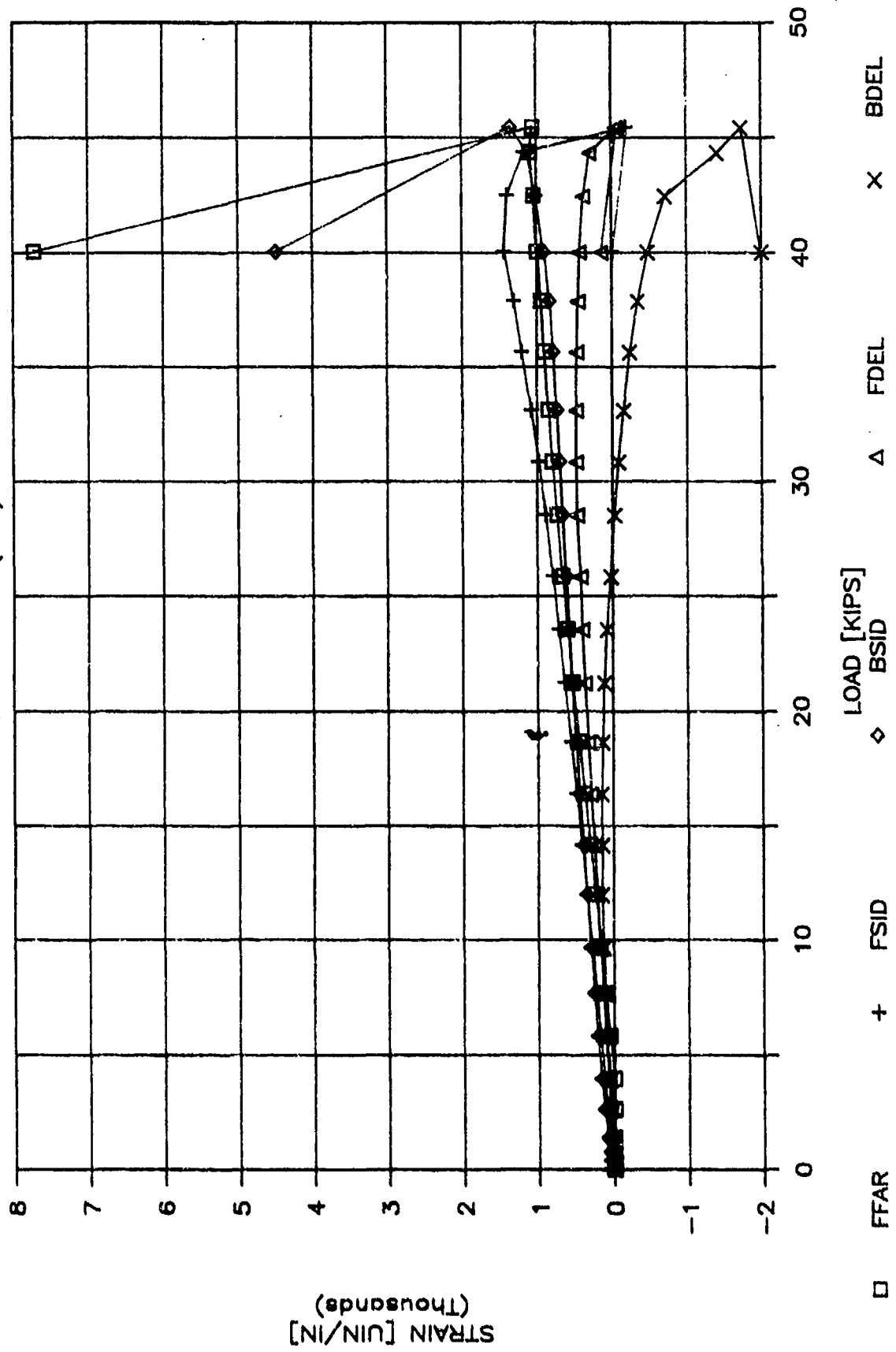


Figure B-194. Panel 2-15-10 Residual Compression Data